

APRIL 1963

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Popular Science

Monthly

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Drivers
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report by
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World's Best-Policed AutoTests

Wernher von Braun
Answers Your Questions
About Inertial Guidance



POWER TOOLS

help you breeze through the toughest jobs



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- C $\frac{3}{8}$ " DRILL A real workhorse
- D $\frac{1}{2}$ " DRILL For those BIG drilling jobs
- E 7" POWER SAW Handles the toughest jobs
- F POLISHER Sands, buffs and polishes
- G HEDGE TRIMMER Lightweight, perfect balance
- H SANDER 2-way; straight or orbital
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GOOD YEAR

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Next Month in Popular Science

- **Vacationing on Wheels.** Big special section tells you how to beat the problems of camping with a car, gives details on camping rigs you can buy, build, or rent.
- **Testing the Hot Compacts.** PS turns its auto experts loose on the hottest compacts to see how they compare.
- **Inventing Is Easier Than Ever.** How new materials and devices can help you turn ideas into money.
- **Jim Roe Tests the Lone Star Cruise Liner II.** PS's fast-traveling boating editor tries out a new outboard on Mobile Bay.

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April 1963

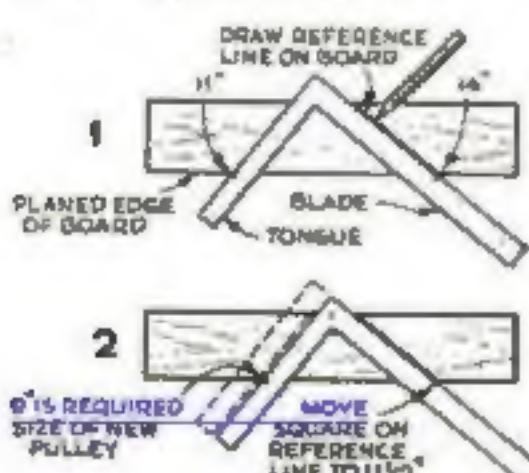
Cover painting by John McDermott



On the river bottom, divers raced against death. Page 124.



How does an astronaut tighten a nut out in space? Page 112.



Shop math with a carpenter's square? Easy as *. Page 132.

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now the 1963 Tempest has Wide-Track!!

(when you're through cheering, go see your dealer)

What calms jumpy roads like Wide-Track? What makes for stability like Wide-Track? Nothing. That's why we widened Tempest's track this year, to go along with its front engine-rear transmission setup. That gives us a car with road-soothing balance all 'round. The dealer to see is your Pontiac dealer. Feel free to finish cheering, if you can wait.

Wide-Track Tempest
Pontiac Motor Division • General Motors Corporation

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PS readers talk back

He's Way Out There—in Space

Congratulations on Dr. Werner von Braun's column. I bought the January issue on the strength of the cover announcement and found his article extremely interesting and most lucid. I look forward to more.

JAMES MARLIN, Nashville, Tenn.

Of Spies and Saviors

I thought "Should You Tell on the Other Driver?" [Jan.] was excellent. About a year ago while driving over a toll bridge, the car ahead of us started weaving. The car hit the right side of the bridge so hard that sparks came from the hubcaps. Ours was the only other car on the bridge. When we arrived at the toll station we were quite shaken, and I told the guard on duty. The driver of the weaving car pulled up only two lanes away, but the guard insisted that unless I made charges he could not or would not stop him. Nor did he contact a State Police car to be on the alert.

With four small children in our car, we felt we could not risk being detained. But I have since decided that it is better to stop and press charges against a driver obviously unfit to drive. Who knows whose life will be saved?

Mrs. F. MEYER, Southington, Conn.

... I was surprised to find PS promoting a police state in this country. Are we not har-



assed enough by highway stormtroopers at every turn of the wheel? Let's not turn our citizens into spies.

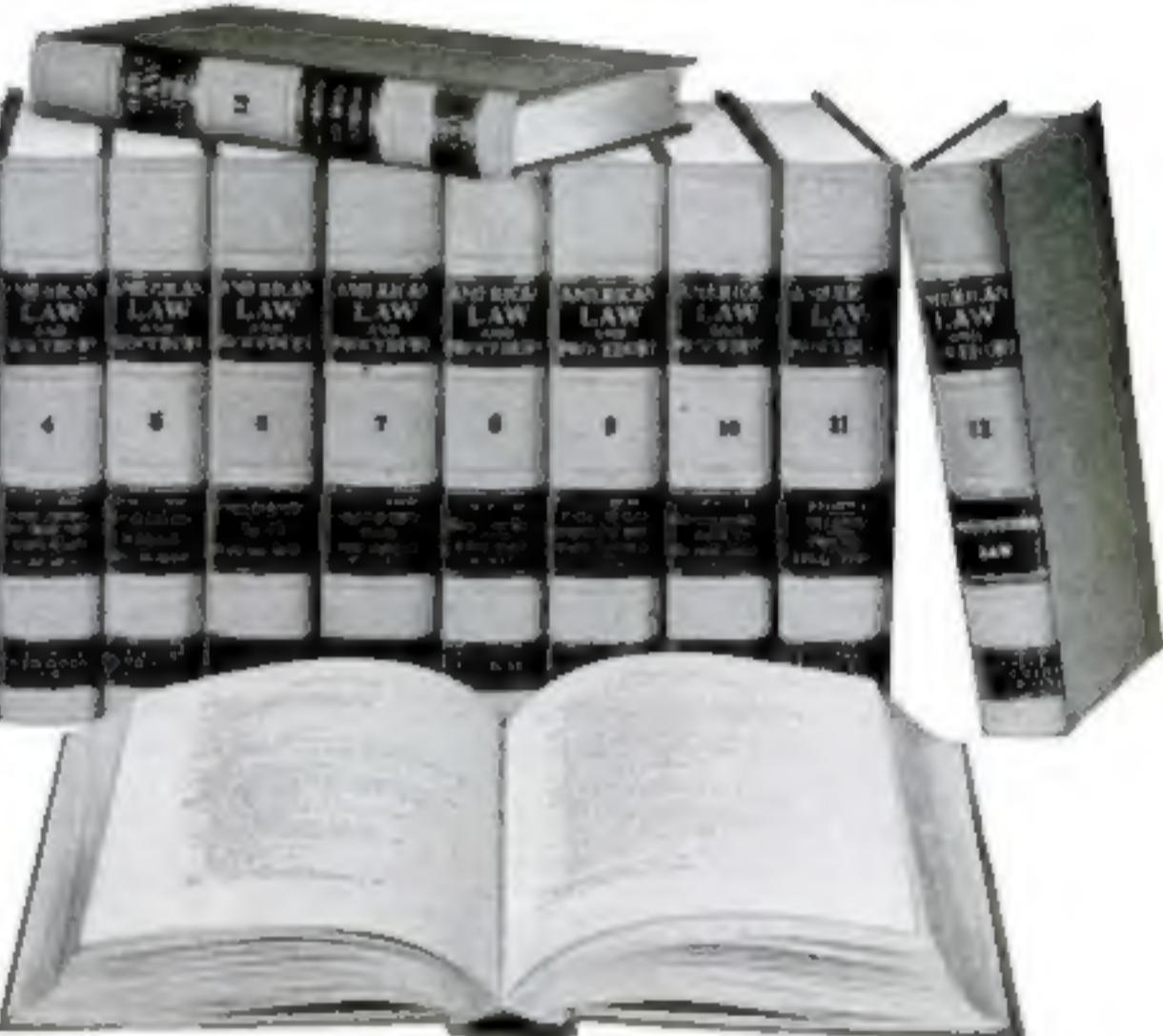
C. O. PRESCOTT, LaGrange, Ill.

... I was the author of the plan for highway observers in Connecticut. Unfortunately, the mention of police gave many people the impression of a highway Gestapo. Actually, the card notification could have been handled other than by the police. The plan was never designed to deal with "highway criminals," but to edu-



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cate generally good drivers regarding their individual unsafe driving habits.

It seems impossible for authorities and laymen to conceive of highway safety as an educational as well as a law-enforcement problem. In other fields of danger, only special attention to specific unsafe acts of the individual has had dramatic results.

R. C. MERRITT, Ridgefield, Conn.

That Chrysler Turbine Car

Your Detroit Report [Dec.] states that our upcoming turbine cars were designed by Ghia. Actually, the car body was designed in our styling studios, right here at Highland Park. Ghia is doing the construction work for us.

JOHN C. GUENTHER
Chrysler Corp., Highland Park, Mich.

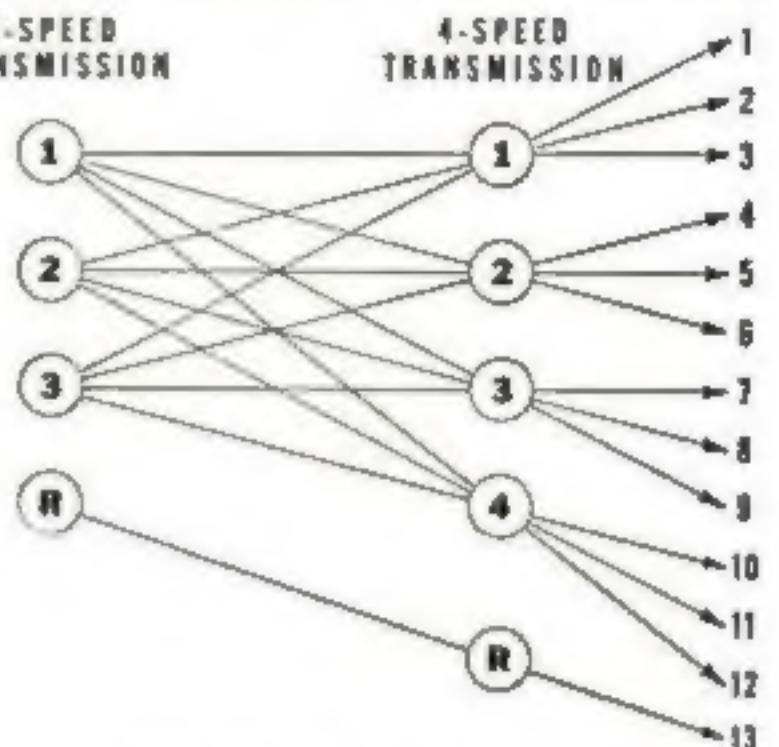
Puzzle of the Month

Counting gears in that hybrid car ["PS Readers Talk Back," Jan.] was an interesting problem. According to my figures, both you and the owner are incorrect. With the Chevy's three forward gears and one reverse and the truck's four forward and one reverse, I say he has a total of 36 forward speeds and seven reverse.

J. E. LAWRENCE SR., Killeen, Tex.

No. We still count only 13 forward speeds.

As we understand Mr. Baker's setup, the first transmission has to drive through the second. The engine cannot drive the second transmission directly, nor can the first transmission drive



the rear end directly. In the diagram, each arrow represents a possible gear combination.

Explorers Did Them Proud

Our post would like to congratulate Ross Allen and the Eagle Scouts and Explorers for successfully completing their survival hike

CONTINUED

Why Johnson built 2 new reels in one

"Build a reel that offers the best of BOTH spin-casting and bait-casting." That's what anglers asked for, and Johnson did it . . . built the Johnson "710". Here's the reel that gives you spinning ease on the cast, bait-casting power on the retrieve. THEN, when a big one runs and you want game-taming drag, simply SHIFT the handle back a fraction of a turn. Drag takes over automatically. Run's over, you resume normal retrieve. Keep the fun of catching fish . . . and keep your catch, too.

Ask your dealer to show you the Johnson "710".

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WRITE for FREE 20-page, full-color booklet crammed with fishing tips, latest Johnson tackle.

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"It makes sort of a tic-tic-tic peep baa-room"

Imagine trying to diagnose an engine's ills from a description like that. And yet, good mechanics do it all the time. That's because most mechanics today are better trained than ever before. And part of that training comes from the makers of Perfect Circle piston rings.

Many years ago we set up our Doctor of Motors clinics to provide mechanics with specialized training in engine maintenance. Over 800,000 men have attended so far!

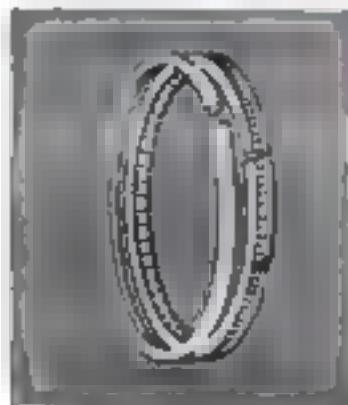
When you want to be sure of top piston ring performance, ask any mechanic about

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Or ask a race driver — 28 of the last 35 Indianapolis winning cars have been Perfect Circle-equipped.

Ask a NASCAR or USAC winner. Year after year more of the major competitions are won with PC-equipped entries than by cars using any other brand of rings.

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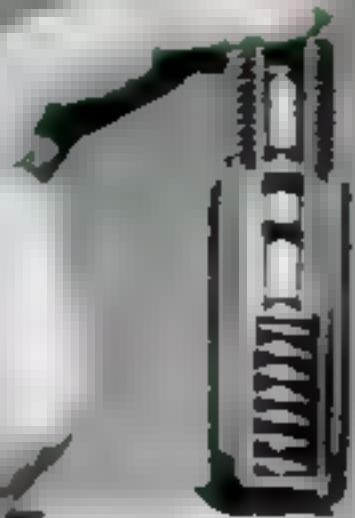
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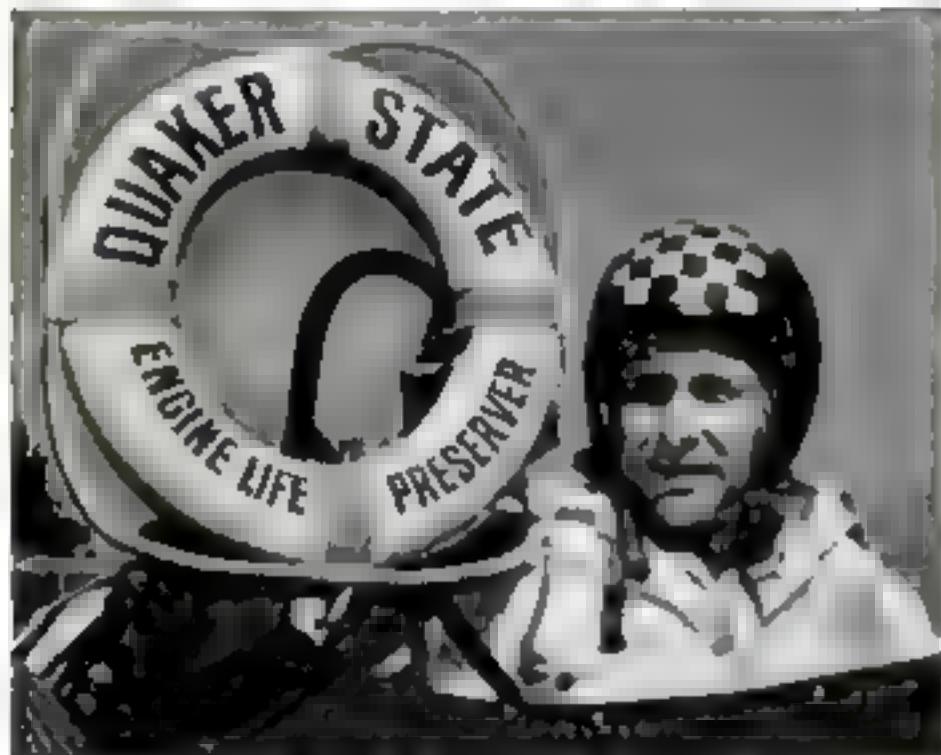
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What is this device? What is its purpose?



What does this symbol stand for?

A "Throttlekicker" (top) prevents engine stall while parking cars with power steering. The life preserver is the symbol of Quaker State Motor Oil—the best engine life preserver. Made from 100% pure Pennsylvania Grade Crude Oil, Quaker State gives every car longer-lasting lubrication, top protection. Insist on Quaker State—your best engine life preserver.



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across Florida ("American Kids Can Take It," Feb.). Incidentally, Exploring is a program of the Boy Scouts; there are no "Explorer Scouts." You are either a Boy Scout or an Explorer.

JERRY ANCONA, V.P.

Explorer Post 30, Montgomery, N. Y.

Dogs on the Force

In "Canine Cops Put Teeth in the Law" [Jan.], you quote Police Chief William M. Lombard "of Buffalo." Happily for us, Chief Lombard directs the police at Rochester, N. Y.

HAROLD CRECHTER, Rochester, N. Y.

Apologies to Chief Lombard of Rochester; and to Buffalo's Police Chief Howard E. Finney, whose force has a 17-dog unit of its own.

. . . You say seven years ago no U. S. city had dogs on its police force. What about Berkeley, Calif., where Dobermanns were on duty in the late Thirties?

ELMO JONES, Mountain Lakes, N. J.

That Antique Valveless Engine

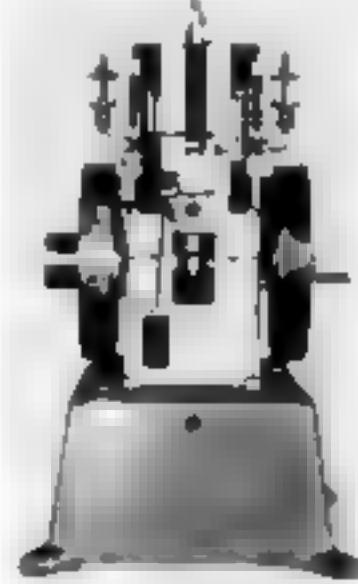
The curious gas engine owned by Mr. Bundy ("PS Readers Talk Back," Jan.) was patented by my uncle, Henry R. Sieverkropp, in 1910. Its unique cylinder design eliminated precompression of the fuel, or charge, in the crankcase.

The cylinders lie on either side of a compartment, cast in the same block. Two pistons work in unison, connected by one wrist pin, with a single connecting rod in the compartment. Only the compartment's lower end is open to the crankcase; the cylinders' lower ends are sealed off, but connected together by the precompression chamber.

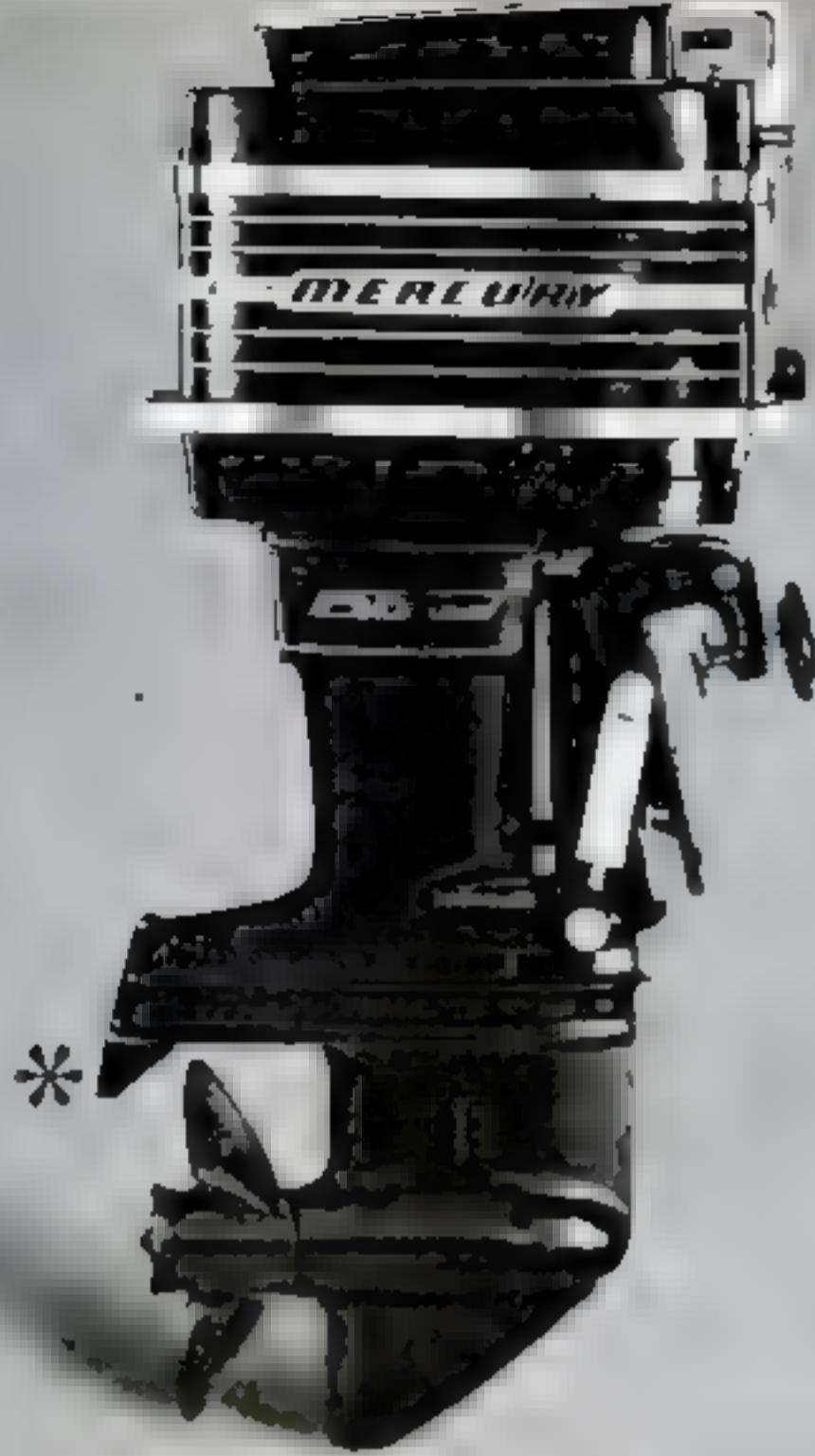
A fuel-mixer, poppet-valve carb of suction type on the lower end of the chamber is connected to a cast-iron gasoline tank (and engine mount). A centrifugal governor in one flywheel controls speed. The engine turns out its three hp. as follows:

On the down stroke, the charge below the pistons is compressed in the lower end of the cylinders and in the precompression chamber. Near the end of the stroke, the pistons uncover exhaust ports in the cylinders, discharging the spent charge. Immediately, the pistons uncover intake ports connected to the lower precompression chamber. The trapped charge escapes into the upper ends of the cylinders.

On the up stroke, the intake ports are covered by the pistons and, immediately after, the exhaust ports are covered. As the pistons



CONTINUED



New Merc 650/65 hp/4 cylinders

One part on a Merc is designed to wear out

* This is a trim tab. It may be adjusted with a simple hand tool to offset engine torque for easy steering. This year, it has been designed to wear out. Here's why:

Up to now, outboarders using bronze propellers in salt water had a corrosion problem. When two unlike metals, such as bronze and aluminum, are submerged in salt water, an action is set up called galvanic corrosion. It is the reverse of plating one metal with another, causing one of the metals to be eaten away.

Mercury's new trim tab is cast from a special self-sacrificing alloy. In salt water, it allows itself to be slowly "eaten away"... thereby protecting the other metal parts of your motor. When your motor begins to steer hard, it's time to replace the trim tab. And,

a new one costs only a buck. In fresh water, it lasts like aluminum.

A small thing, perhaps... but another example of the tender, loving care in design, proving, and production to give you more RUN for your money with Mercury.

MERCURY

100, 85, 65, 50, 35, 20, 9 8 and 6 hp outboards



MerCruiser Stern Drive
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190, 140, and 110 hp gasoline
100 and 39 hp diesel

© 1963, KIEKHAEFER CORPORATION, Fond du Lac, Wisconsin
Subsidiary of Brunswick Corp.

New, improved Chevrolet Corvan...toughest,



Corvan on Powell St. hill in busy San Francisco.

Checked out 40,000 miles in city, mountain, desert driving. A king-sized delivery run demonstrated the toughness of this quality-built Corvair 95 Corvan.

We just kept rolling along—and rolling and rolling and rolling! In a grueling performance test that criss-crossed the country from Detroit to San Francisco, a 1963 Corvan ran up 40,000 miles of trouble-free performance under all conditions—highways, desert heat, driving rain (with nearly 7,000 miles of stop-and-go running through the busy city streets of hilly San Francisco!).

You'll like the extra durability of the new Corvan. There's added toughness from new features such as heavy-duty engine

valves, self-adjusting brakes and improved clutch and transmission controls.

You'll also like the Corvan's handy utility . . . big easy-to-get-at cargo space resulting from space-saving rear-engine design.

Big double doors on the right side open up to a load floor only 16" off the ground so that you can load a 4-foot crate with ease. There are wide-opening double doors at the rear and optional* double doors on the left side just as big as those on the

handiest delivery truck you can buy!



Chevrolet Greenbrier and Rampside Pickup accompany Corvan on 25,000-mile leg of endurance run in Death Valley desert country. Here, day-and-night high-speed operation showed durability of improved new air-cooled engine.

right. All 191 cubic feet of cargo space is there to be used—easily and quickly.

Rear-engine Corvan design also gives you other important benefits. Extra weight on the rear wheels gives surefooted traction on slippery roads. And with the main cargo space cradled near the center of the truck, you get balanced handling whether the truck is empty or carrying a full 1,700-lb. payload.

We'll say it again—the new, improved Chevrolet Corvan is the toughest, handiest

delivery truck you can buy! Test-drive it yourself at your Chevrolet dealer's—and be sure to ask him about the *new low price!* . . . Chevrolet Division of General Motors, Detroit 2, Michigan.

"Erin Cost



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16-FOOT
SUPER
MEZURALL

NEW

LUFKIN 16-FOOTER

works fast on 4-foot modules

The 16-foot White Clad® blade is $\frac{1}{4}$ inch wide and accurately graduated. Marked in consecutive inches to 16ths inch on lower edge; first 12 inches to 32nds inch. Marked in feet and inches to 16ths inch on upper edge, with preceding foot number indicated each inch.

Its self-adjusting end hook compensates for its width on butt-end measurements. And its blade can be replaced in seconds without tools.

It's amazingly lightweight...only 7 $\frac{1}{2}$ ounces with die-cast, chrome-plated aluminum case. Easy to handle. Convenient to use.

Ask your hardware or building-supply dealer to show you this great Lufkin 16-foot Super Mezurall. Retails for approximately \$3.95, including handy vinyl belt pouch.

Measure for measure, the finest made...

LUFKIN
SAGINAW, MICHIGAN

continue upward, trapped gas in the cylinders' upper ends is compressed and a fresh charge is drawn into the lower end of the cylinders and into the chamber.

A standard spark plug fires the compressed charge in the firing chamber and the explosion drives the pistons downward. There's a power stroke on every revolution of the crankshaft.

MACK STEVERKROPP, Racine, Wis.

The inventor's daughter, Mrs. Milo Sorenson, supplies this further information from her father, now 85: Two drip oilers on the cylinders lubricate pistons and wrist-pin bearings. Connecting-rod and crankshaft bearings are lubed by the crankcase oil. No oil is mixed with the fuel. The engines were used primarily on farms and to run washing machines.

The Gentle Touch

The fellow townsmen who gave Reverend Few prescriptions for discouraging auto thieves ("PS Readers Talk Back," Dec.) sure have a sense of humor. Hooking up a gun to fire buckshot at the driver's seat may have been suggested for laughs, but it could be worked at that! Take the buckshot from the shells and fill 'em with rice or—more unkind—with hard rock salt which will give a more lasting sting. This will leave the car thief in one piece so the law can take its course.



BILL COON, Chester, N.J.

Advice for the Car-Lorn

Tell that Dodge Lancer owner troubled with hard starting ("PS Readers Talk Back," Feb.) to have his dealer take another look. I'm sure he'll find an in-line fuel filter sitting warm and cozy over the rocker-arm cover. This little innovation has caused no end of problems. The solution is simply to get the filter away from the engine heat by moving or insulating it.

RICHARD OESTREICH, Canandaigua, N.Y.

. . . The fuel-pump pressure of that Lancer is too high. When the motor is shut off the high pressure on the fuel forces it past the float valve and floods the manifolds. Then, when trying to start, the engine is flooded. A fuel-pressure regulator placed between the pump and carburetor solves the problem.

RICHARD KING, Salem, Ore.

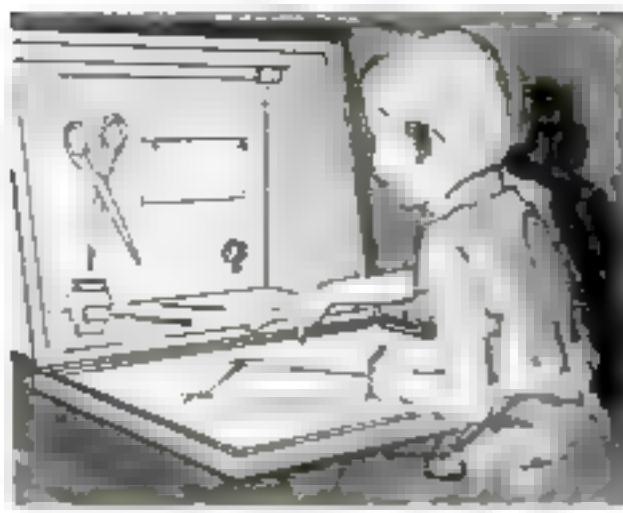
. . . Jakabein's trouble is a faulty spark coil that is shorted by heat. Perhaps moving the (new) coil would prevent this.

R. E. PALMER, Kansas City.

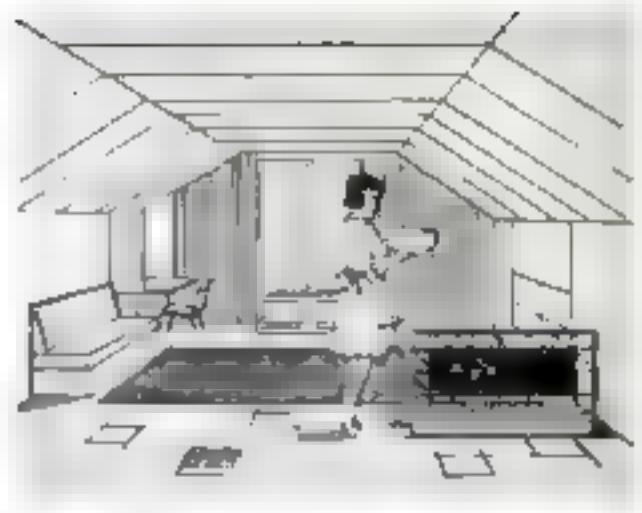
. . . I'd say Jakabein has a leaky check valve in his Lancer's carb. He should clean and re-



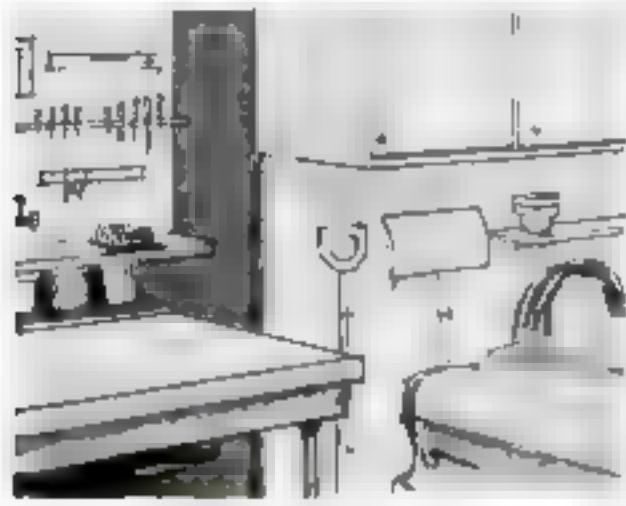
1. Fences of distinctive design



2. Wall desk with optional chalkboard front



3. Remodeled attic



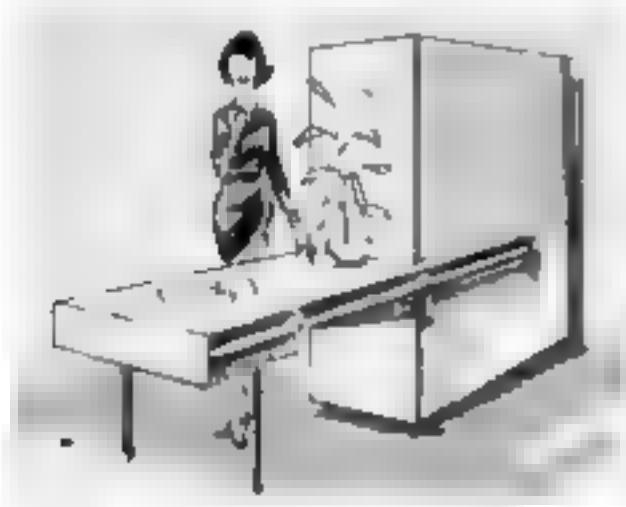
4. Garage interior remodeling



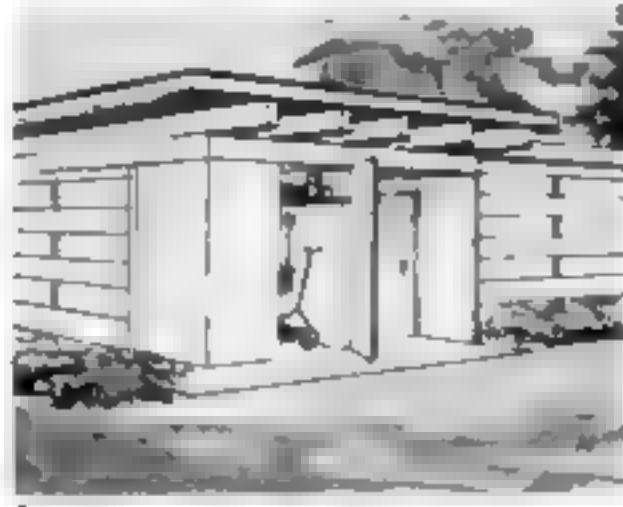
5. Picnic table and benches, lawn chair



6. The sports rack



7. Room divider with desk and wardrobe



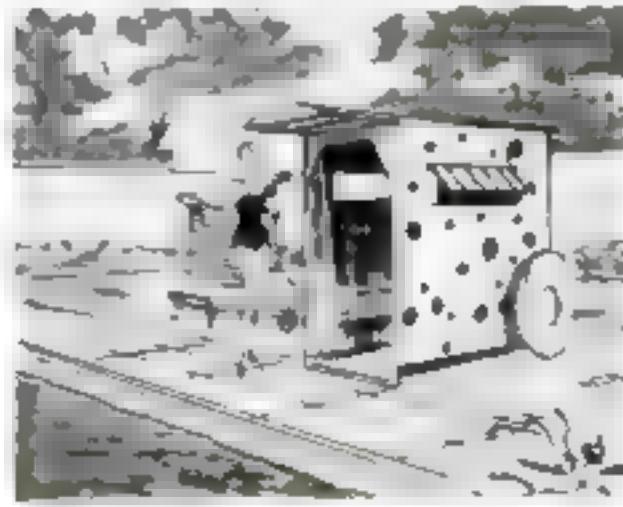
8. Woven carport wall with tool room



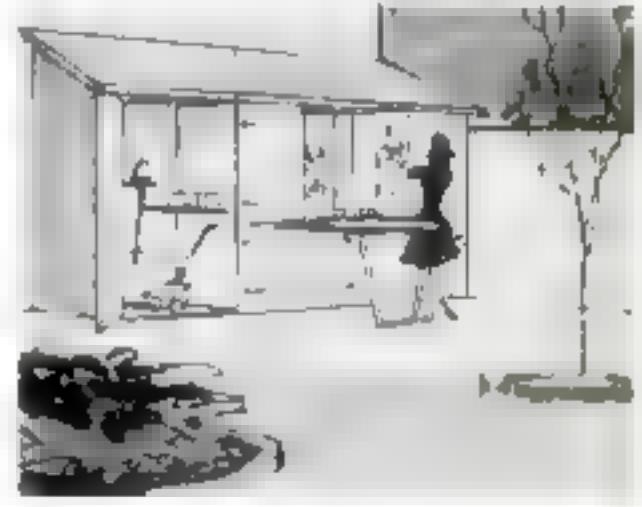
9. Playhouse plan for children



10. Home entertainment center
Family leisure hi-fi center



11. Roll-away cabana



12. Outdoor living room

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Best time to change oil: Every 60 days, normally. Every 30 days under severe stop-and-go or cold-weather driving conditions.



seat it. When the engine stops with pressure on the fuel line, gas seeps through the valve, raises the gas level, and loads up the manifold. He can check this by removing the air cleaner a few times and peering down the barrel, right after stopping the motor. A couple of tries should catch the culprit in the act of soaking the manifold.

H. E. SHELLMER, Madison, N. J.

Woman at Work!

Let's have more of Jackson Hand ("How to Change a Faucet Washer When There Isn't One," Jan.). I now have about two inches of water on my bathroom floor, and I find it exceedingly difficult to become pals with the several packages of rubber washers I have had to purchase to carry on. Certainly Mr. Hand was correct to a point:

(1) Those little handles were canopies to hide working parts. (2) It was necessary to remove the handles before going inside. (3) There was not even a packing nut. (4) All working parts were removable.

But now that I have the darn thing apart, using a Philips screwdriver as told, how do I get the faucet back together again? Mr. Hand does not say what to do when one wears away the screw threads by using pliers instead of a wrench.

May I suggest—as a public service to those of us confined to the bathroom with a thumb in the spigot—a follow-up article: "How to Make Friends with a Wretched Wrench."

BETTE J. SOLDWEDEL, Piermont, N.Y.

(1) Get someone to turn off the water. (2) Buy a new faucet. (3) Use the right tool from the toolbox to install it.

More Trade for the Junkies?

That extended-lubrication stuff ("30,000 Miles Between Grease Jobs," Jan.) is a sales gimmick to move a few more slow-selling cars. Only the junkyards will benefit.

HORACE A. GILTNER, Peoria, Ill.

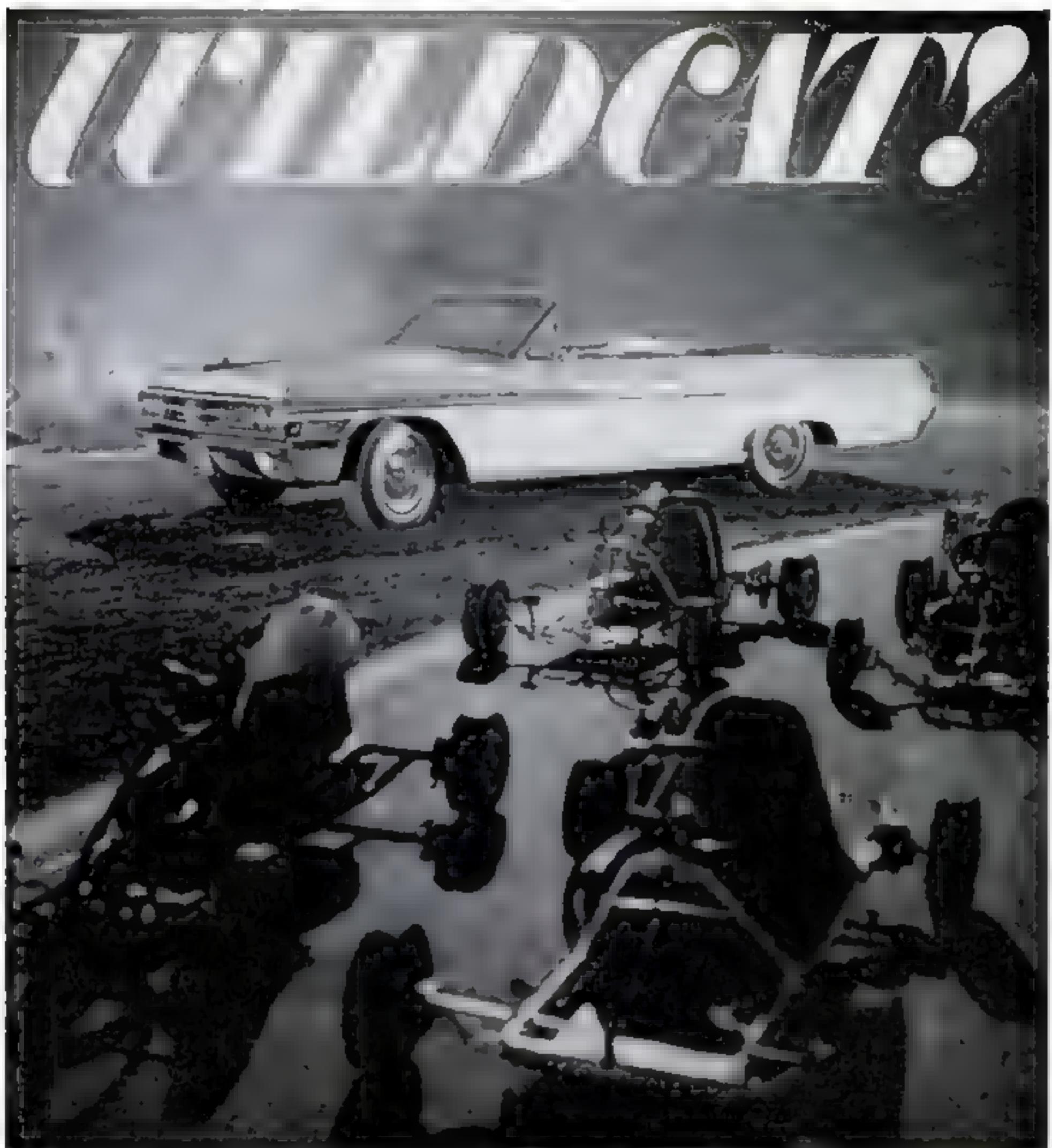
Synchronized-Transmission Debate

Let me straighten out Gary Gernert ("PS Readers Talk Back," Jan.). Packard did not have a transmission synchronized on all three gears from 1938 to 1954. What they did have was a constant-mesh low gear engaged by a dog clutch—similar to all modern second and high engaging clutches, but without any brass synchronizing ring on low gear. Only the column-shift versions from 1940 on had the constant-mesh low gear.

The Packard transmission was an engineering masterpiece with the widest, strongest gears in the automotive industry: all forward gears constant-mesh, and all gears supported on double ball bearings, roller, or needle bearings.

R. L. RAVENSBORG, St. Paul, Minn.

Hear "Chet Huntley's Perspective on the News" Monday through Friday, NBC Radio Network



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Buick Motor Division also presents: Buick Special/Skyhawk/LeSabre/Electra 225. Rivers.



ANATOMY OF A WILDCAT! Engine: 90° V-8 valve in head. Displacement: 401 cu. in. Maximum hp. 325 for 4400 rpm. Compression 10.25:1. Bore and stroke 4.1875 x 3.64. Carburetor: one 4-bbl. downdraft. Valves hydraulic. Gear type: Rear axle hypoid som. Floating. Gear ratio: 3.42. Transmission: automatic torque converter type. Brakes: 12" Duo-Servo, finned aluminum up front. Advanced Thrust engineering for straight tracking. Flat cornering.



Dr. von Braun watches a Juno II launching from Cape Canaveral block-house. In background is Dr. Kurt Debus, Launch Director at the Cape.

Dr. Wernher von Braun Answers Your Questions on Inertial Guidance

Q *Why does a rocket need a guidance system?*

A To keep a rocket on its prescribed flight path despite disturbances by wind, or by slight deviations from the rocket's standard weight or performance, we must continuously generate and apply commands that correct its motion. We can take our choice of two guidance systems: remote control or inertial guidance.

Guidance commands may be generated by tracking the rocket with optical instruments, radar, or radio, and comparing the *actual* track with the *prescribed* flight path. A remote-control command passed on by radio instructs the speeding rocket to reduce any difference between "is" and "should be" to zero.

Such guidance systems, based on remote control by radio, have several basic drawbacks. For one, they are subject to intentional as well as unintended interference, which makes them particularly vulnerable in military operations. For space-flight operations, an even more serious drawback lies in the fact that it is impossible to maintain radio contact between ground station and rocket except along a line of sight between them. For economy in consumption of propellant, an orbital rocket must ascend to its orbit along a very shallow trajectory—and so the burn-out point of the last rocket stage is frequently well below the horizon of the launching site.

In deep-space missions, the rocket may

stay in one or several "parking orbits," and must restart its engine at a very precise instant for the ensuing power maneuver that leads to injection into a trajectory to the moon or the target planet. The orbital restart point may be over Australia or the Pacific Ocean, while the launching was from Cape Canaveral, Fla. Radio-guidance schemes for such operations would involve a complicated globe-circling network.

An inertial-guidance system does away with all these communication difficulties by generating the guidance commands *on board the rocket*. Such a system is entirely self-contained.

Q *What is the principle of inertial guidance?*

A The basic idea behind an inertial-guidance system for a rocket is to measure its accelerations in three "orthogonal" (mutually perpendicular) directions, such as up-and-down, right-and-left, fore-and-aft. The three accelerations then are "integrated," an operation that a following paragraph will make clear, to obtain the velocity in each direction. In turn, the three velocities are integrated to get the *displacement*, or distance traveled, in each direction. This answers the rocket's ever-repeated query, "Where am I?"

Knowing from an electronic memory where the rocket *ought* to be at any moment, and noting any deviation, the

You're always in good company when you

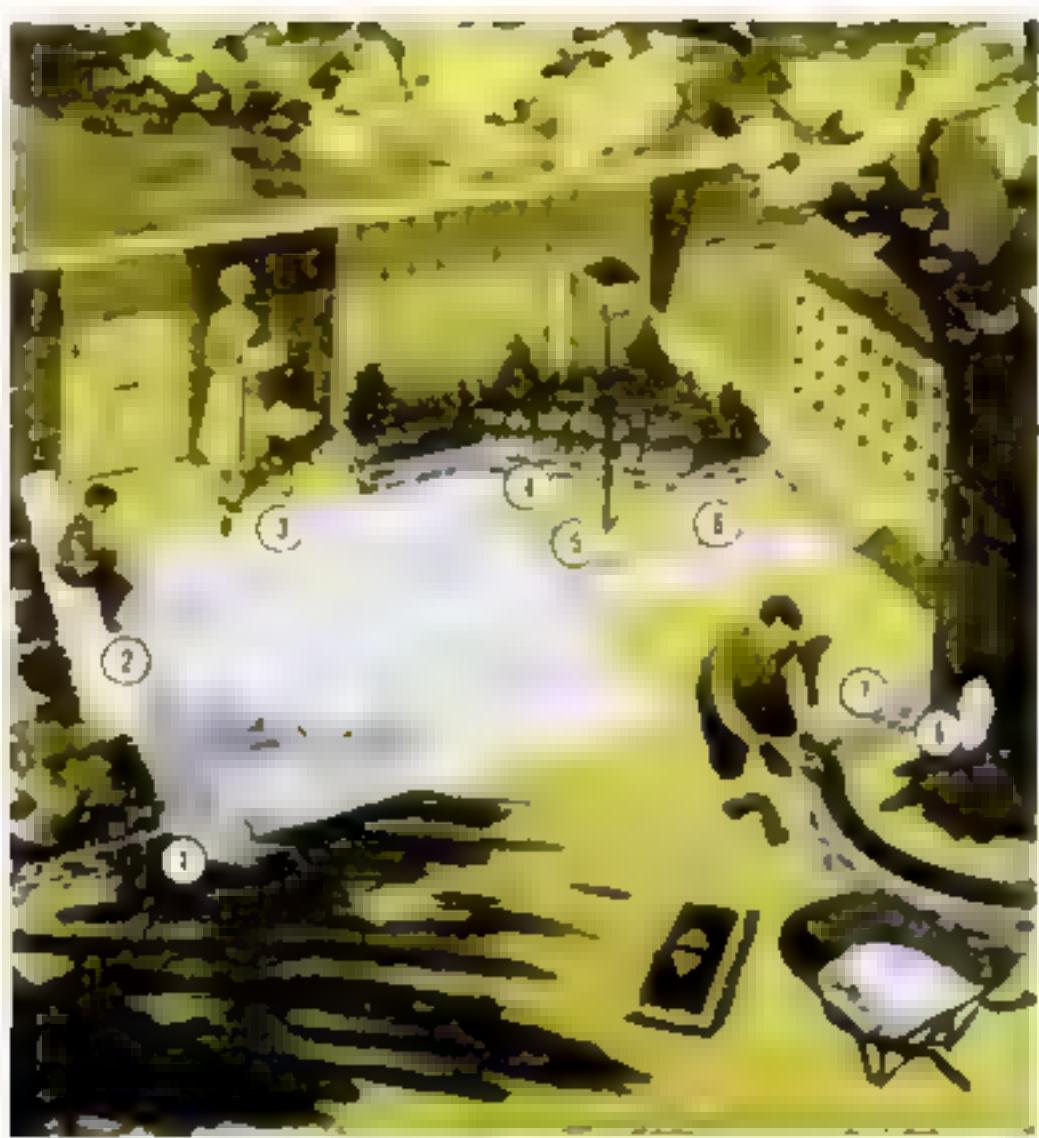
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guidance system produces the needed commands to correct the flight path.

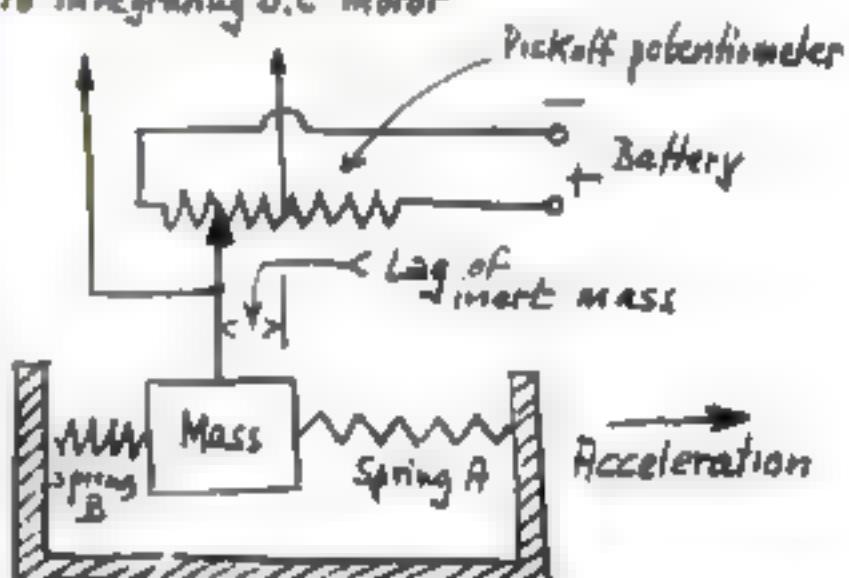
The heart of any inertial-guidance system is thus a set of three orthogonal accelerometers, to measure the three components of the rocket's acceleration.

Q *How can you measure acceleration?*

A Acceleration is what sports-car drivers call "getaway." It manifests itself as a force that presses the driver against his seat back when he steps on the accelerator. This force is the result of his body's inertia, which resists the sudden change of pace—whether the car is accelerating from a standstill, or from 40 to 60 m.p.h. to pass a lumbering truck.

There are many types of accelerometers, but they all measure that "force against the seat back" due to the inher-

To integrating d.C motor

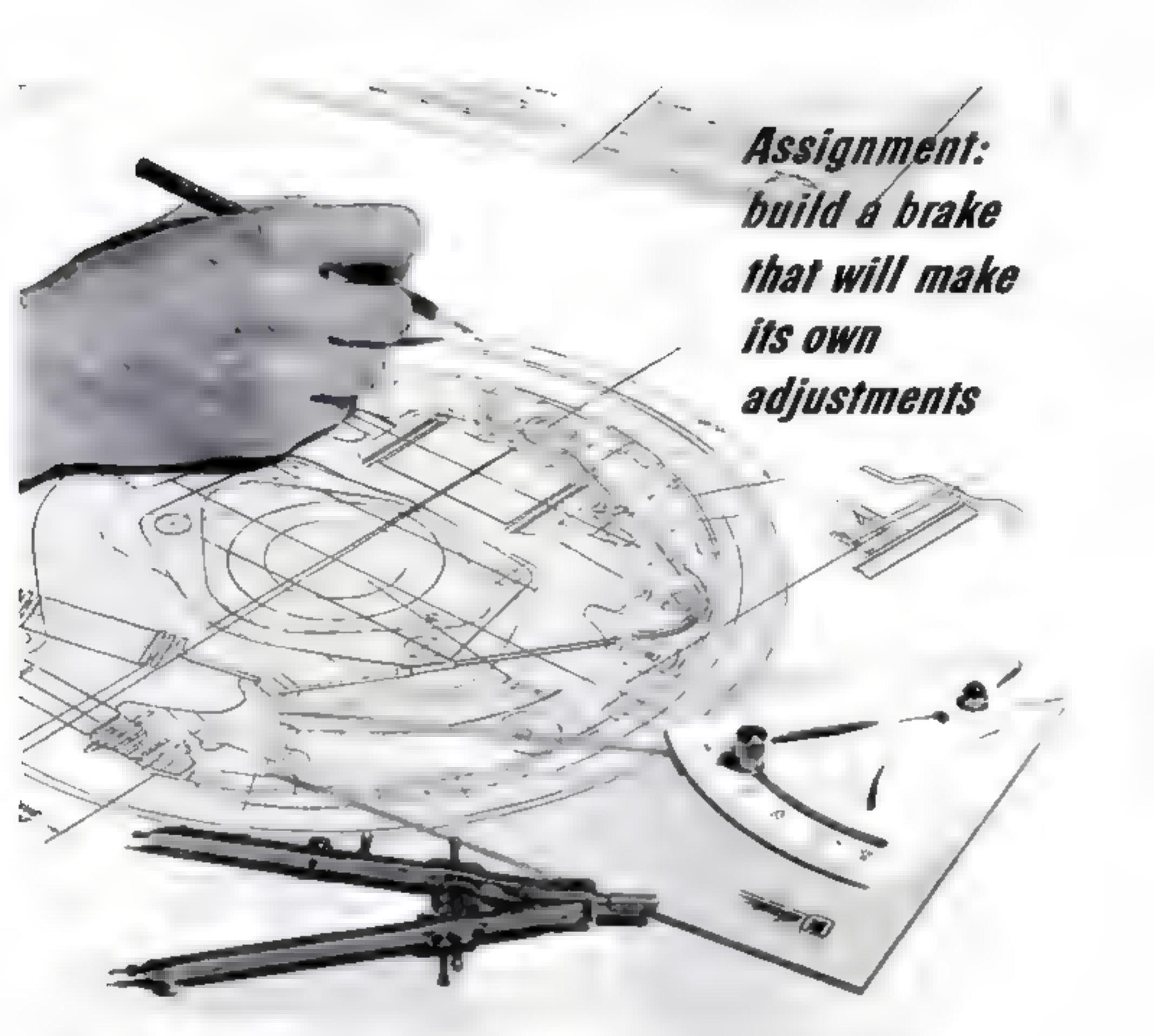


ent inertia of mass. The simplest is the spring-mass accelerometer in my sketch.

As the rocket accelerates in the direction shown by the arrow, the inertia of the mass causes it to lag behind, stretching spring A and compressing spring B. A sliding-contact variable resistor, labeled "pickoff potentiometer," produces a voltage that corresponds to the acceleration at any instant.

Q *How are accelerations integrated?*

A The speedometer in our sports car clearly indicates that the velocity is increasing, second by second, as long as we feel that pressure against the seat



**Assignment:
build a brake
that will make
its own
adjustments**

Result: Every Ford-built car in '63 has self-adjusting brakes

"Give us a brake," Ford Motor Company engineers were told, "that will automatically compensate for lining wear whenever an adjustment is needed—and make it work for the entire life of the lining."

Today, not only does every Ford built car (Falcon extra-duty bus type wagons excluded) have self-adjusting brakes, but the design is so excellent that adjustments can be made more precisely than by hand.

This Ford-pioneered concept is not complex. Key to it is a simple mechanism which automatically maintains proper clearance between brake drum and

lining. Self-adjustment—which normally occurs but once in several hundred miles of driving—takes place when brakes are applied while backing up.

The quest for total quality in Ford built cars has produced other extra-value features like extended major chassis lubrication intervals, use of rust-resistant galvanized steel for vital underbody parts and new, longer-life electrical systems.

Such achievements through engineering excellence are reasons for Ford Motor Company's success in bringing you quality cars that last longer, need less care and keep their value better.

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Joe E. Oppenheim
Great Neck, N. Y.

California graduate reports:

" . . . a new contract gives 83¢ an hr. raise over the next three years; now getting \$4.53½ an hr. . . . also paid holidays."

Paul Van Wettering
Van Nuys, Calif.



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back. Of course, the speedometer is rigged to the wheels and really tells how fast they're spinning. But we could build another speedometer around our spring-mass accelerometer:

Suppose we drive a little DC electric motor with the voltage from the accelerometer's pickoff potentiometer. The motor will spin as long as there is an acceleration, stop as soon as it ends.

The speed at which the motor's armature revolves corresponds to the voltage supplied by the pickoff potentiometer, which in turn corresponds to the acceleration. But the total number of turns that the armature makes, over a given period of time, corresponds to the velocity built up as a result of the acceleration during that same period.

Thus, all we have to do to get our accelerometer-driven speedometer is to attach an indicator needle to the armature of the little motor—over a high gear ratio, of course. Our new speedometer is the prototype of what guidance people call an "integrating accelerometer."

We could stick a second potentiometer on the needle axis of our new instrument, and drive a second electric motor with the voltage output. Since the picked-off voltage corresponds to the car's velocity, the second electric motor will spin at a rate corresponding to that velocity, and the total number of revolutions made by its armature will correspond to the distance traveled by the car. A needle attached to the second motor, again over a high gear ratio, will show the mileage covered—giving the same reading as the car's standard odometer. (The latter counts the total number of turns made by the wheels.) With the second electric motor we've performed the "second integration"—we have integrated velocity over time elapsed and found the distance traveled.

Q Is there more to designing a practical rocket guidance system?

A Yes. The designer is confronted with two principal kinds of difficulties:

1. The rocket changes its attitude



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throughout the flight. At takeoff it stands upright. At injection into orbit it speeds along horizontally. Moreover, as it passes through the atmosphere, it is tossed around by turbulence and shifting wind, changing its attitude temporarily.

Our three orthogonal accelerometers must therefore be placed on a gyroscopically stabilized platform. However the rocket may turn and waver, the three accelerometers will now have and retain a fixed orientation in space. To meet the stringent accuracy requirements of inertial-guidance systems for space rockets, the stabilized platform must maintain its angular position within a fraction of a degree, for several hours.

2. Any mass permitted to make constrained movements is subject to friction. In our spring-mass accelerometer, for instance, the inert mass is constrained by springs, whose stretching or squeezing involves some friction. (Just bend a piece of wire a few times, rapidly, and feel the heat produced by the friction!) Also, unless the accelerometer

operates in a vacuum, there will be air friction. The potentiometer pickoff is another source of friction.

All this friction reduces the accuracy of the whole system. It is no overstatement to say that the success of modern inertial-guidance systems is the direct result of a relentless fight against friction. Many methods have been tested in this fight:

There are "floatation bearings" where the suspended mass floats in a fluid of equal density. There are "gas bearings" in which the suspended mass rides upon a cushion of air or nitrogen. There are electrostatic supports, and even magnetic supports, which utilize the strange effects of electrical superconductivity at extremely low temperatures.

Accuracy of the system is improved, too, by increasing the forces created by acceleration. Gyro accelerometers, utilizing the phenomenon of gyroscopic "precession," have proved superior to simple mass-spring accelerometers.

Further gains in accuracy have come

CONTINUED



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Present-day inertial-guidance systems can place a satellite in orbit with an injection accuracy of a few feet per second in velocity, and a fraction of a mile in altitude.

Q *What is a solar battery?*

A It is a source of electrical power for spacecraft. A solar battery is made up of a bank of solar cells. These are small shingles of pure silicon, whose outer surfaces have been contaminated by exposure to boron vapor. Sunlight striking these cells is converted directly into current. Here is how this works:

The smallest unit to which electricity can be reduced is the *electron*. Similarly, light energy cannot be subdivided beyond a unit called a *photon*.

A light photon impinging on the boron-contaminated surface of a silicon shingle is absorbed within a layer not exceeding 1/100,000 of an inch in depth. Its absorption invariably leads to the displacement of an electron. While free electrons are few and far between within the boron-containing layer, they are in ample supply in the pure silicon beneath. As a result, when enough energy has been imparted to a displaced electron to propel it from the boron-doped layer into the pure-silicon region, it is free to move into an external circuit where it helps to deliver power.

Solar batteries produce only a few watts of electrical power per square foot of panel surface. In order to drive high-powered transmitters for deep-space communication, they usually feed their weak but round-the-clock power into a chemical storage battery capable of high-power, short-time discharge. ■ ■

Dr. von Braun will consider answering questions from readers of **POPULAR SCIENCE** in the magazine, but he cannot undertake to answer each one by mail. Letters to him should be addressed in care of **POPULAR SCIENCE**, 355 Lexington Ave., New York 17, N.Y.



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Science newsfront

BY WALLACE CLOUD

A monthly report: What's going on in science and why it's important to you

PHYSIOLOGY

Revolution in breathing

If mice, rats, and dogs can become water-breathing creatures, so can men. This is the conclusion of a scientist who kept mice alive for up to 18 hours under water and helped dogs to successfully re-adapt to normal respiration after breathing water.

These fantastic events took place in the laboratory of Dr. Johannes A. Kylstra at the University of Leiden, Netherlands. In this country, Dr. John W. Severinghaus of the University of California Medical Center is doing similar work with rats, but four hours is the longest they have survived under water.

Physiologists started wondering if it could be done after research indicated that unborn babies "breathe" in the womb, although their lungs are filled with fluid. It began to seem logical that lungs could serve as gills.

To give the animals a better chance to survive, Dr. Kylstra made special water by mixing up a balanced salt solution matching the salinity of body fluids that normally bathe the lung sacs (about a third as salty as the sea). The solution was buffered with a chemical that reacts with exhaled carbon dioxide. Then the concentration of dissolved oxygen was increased by shaking the fluid with pure oxygen under pressure. Animals enter the compression chamber through an air lock. A pressure of about eight atmospheres provides an animal with the amount of oxygen it would get from air, but Dr. Kylstra reports increased survival times at pressures up to 180 atmospheres (equivalent to the pressure a mile deep in the ocean).

Dogs removed from the chamber had their lungs pumped out with oxygen and have survived with no aftereffects. Mice are too small to make resuscitation practical, but the California researchers drained the lungs of their rats and even forced oxygen into their lungs. The rats lived for only half an hour in air, survived up to 21 hours

with positive-pressure oxygen breathing.

We asked Dr. Kylstra if his experiments lend credence to predictions made by Commandant Jacques-Yves Cousteau, inventor of the aqualung, that man will eventually be able to live beneath the sea without air-breathing apparatus. He replied, "If Cousteau could change the water in the oceans, he might be able to live as a true *homo aquaticus*... However, it might be possible to use an appropriate fluid instead of a gas mixture in a Scuba."

SPACE

Bones and Mercury 9

Will astronauts of the future come back from long voyages at zero gravity with rubbery bones? The ninth Mercury space flight may help answer that question.

Air Force Major Leroy Gordon Cooper Jr., whose flight was originally scheduled for April 2, will probably be the last man to orbit the earth in a Mercury capsule. But his trip will be the longest U.S. space voyage to date. Official plans are for at



Space broom. To clean up the Van Allen belts [see "Van Allen Tells What Space Is Really Like," page 73], physicist Alan Rosen of Space Technology Laboratories suggests a large flat satellite that would spiral out from earth, knocking radiation particles harmlessly out of the belts. A satellite with an area of 250 acres would take 35 days to sweep all high-energy particles from the zone of the artificial radiation belt created by last summer's high-altitude bomb test. That's beyond the state of the art, he says, but smaller, slower space brooms may be feasible.

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Science newsfront continued

least 18 orbits (26 hours), maybe 22 orbits (34 hours). Cooper said in a press conference that he will go for more than 22 if his oxygen and fuel hold out. The launch was postponed for installation of an improved autopilot in the Atlas rocket.

There is some worry among space-medicine men that long periods of weightlessness may cause loss of calcium from the bones. At zero gravity, the usual bumps and stresses on the bones are eliminated, reducing the stimulus for normal replacement of bone material. Dr. Stanley C. White of the National Aeronautics and Space Administration says Russian space scientists have confided that they found increased calcium in the urine of their cosmonauts after the twin-orbit flight last August. During his Mercury flight, Cooper will collect urine samples periodically in a set of plastic bottles. Analysis of the urine may shed light on bone softening.

Other experiments are also aimed at collection of data on the physiological effects of weightlessness. Major Cooper is expected to sleep in orbit, perhaps alternating eight hours on duty with four hours of sack time. He will try out the new freeze-dried concentrated space food, which has to be reconstituted in flight by adding water; NASA officials say it's delicious. He will also let the air out of the Mercury capsule to test the emergency value of his space suit in case of sudden decompression.

Extra-terrestrial news. Two far-off stars recently exploded, producing a nova and a supernova. The brighter supernova, found by an Italian astronomer, is too far away to see without a large telescope (it's to the north in Coma Berenices). The nova can be seen with the naked eye in the early-morning sky (located to the northwest in Lyra, close to the bright star Vega). It was sighted almost simultaneously by a Swedish astronomer and an American amateur, Leslie C. Peltier of Delphos, Ohio.

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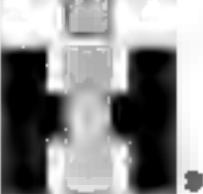
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Science newsfront continued

self is just a spinning flywheel; the rest of the mechanism is a sensing system to pick off the wheel's resistance to changes in direction.

But we're flying blind more and more these days—in airplanes, spacecraft, and submarines—so there's a need for more sensitive "inertial-guidance systems," as the sophisticated gyropilots have come to be called. Designers are looking more deeply into the nature of matter and energy to find things that point more steadily.

The experimental system shown in the photo is a "closed-circuit laser" figured out

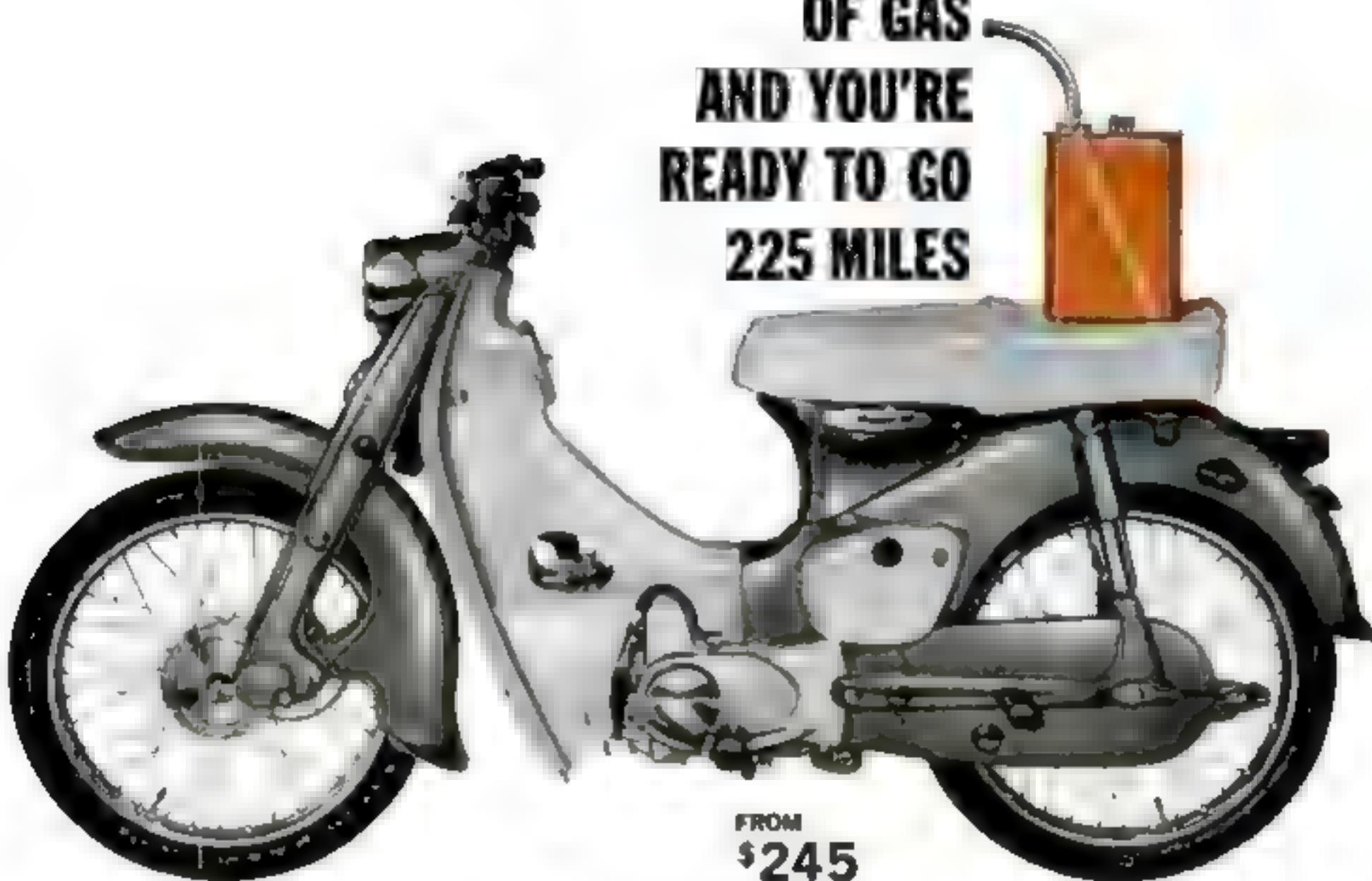


by Sperry Rand. Instead of relying on the inertia of matter, it takes advantage of the constancy of the speed of light and exploits the "coherence" of the light produced by lasers—which means that the light waves put out by a laser are in step.

The four helium-neon gas lasers are stimulated by a radio frequency and synchronously emit coherent light in the infrared range (the visible light is an accompanying spurious emission). The coherent beams shoot out of both ends of each tube. Mirrors at the corners of the square bounce the light so that two counter-rotating beams are kept whirling around the sides of the square. The mirror at the far corner is half-silvered, allowing some of the light to pass through to a photocell in the camerlike box.

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Science newsfront continued

shift). [For a navigational system based on the Doppler effect, see "Flying the Atlantic Without a Navigator," page 86.] Now the two beams are no longer in step, and their wave trains interfere with each other. The difference between the two emerges as a frequency that is sensed by the photocell.

PSYCHOLOGY

Two weeks in a blank world

A "don't-give-a-dam attitude" that lasted up to eight days was the way three men felt after spending 14 days alone and in virtual isolation from their own senses. The experiment was made at the University of Manitoba, Canada, under the supervision of Dr. John P. Zubek.

Individually, two college seniors and a professor spent two weeks in a dome-shaped chamber with toilet facilities and an air conditioner, but with no furniture except an air mattress. Their contact with even this limited environment was muffled by heavy pajamas, fluffy gloves, translucent goggles, and ear muffs wired for "white noise"—a hiss like that of a radio tuned to no station. Food was handed in through a trapdoor in the floor. Singing or talking was not allowed, and the subject was monitored by intercom and closed-circuit TV. The students were each paid \$300 for participating.

Brain waves were recorded at intervals; they slowed down considerably below normal. In contrast to some experiments of a similar nature, the men reported only mild visual hallucinations, such as flickering points of light. But they thought they heard birds singing and waves splashing. When they came back to the world, colors seemed unusually vivid.

Most sensory-deprivation experiments last only a few days. Loss of motivation resulting from long stays in solitary may help us understand the experiences of prisoners of war better, Dr. Zubek said. ■ ■



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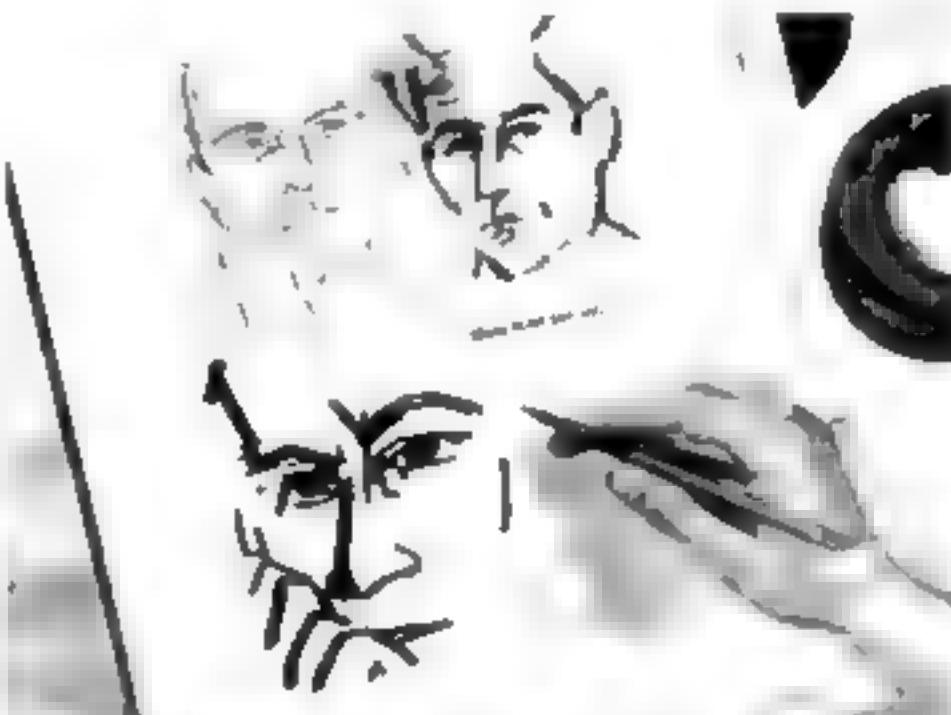
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Getting Ahead

By Dr. Lewis R. Fibel

A monthly column to help you prepare yourself for a better job

The U.S. Patent Office in Washington, as most inventors know, is the place to search for information relating to their ideas and, eventually, the authority that must approve their patent applications. It takes time and highly competent patent examiners to do this work.

Now David L. Ladd, Commissioner of the Patent Office, has announced a plan to train high-school graduates as aides to patent examiners. The program will include formal and on-the-job training in Washington. Starting salary is \$3,820 a year, with increases up to \$8,400. And there'll be opportunities for promotion.

Applicants must have a good background in high-school science and mathematics and qualify in a nationwide Civil Service examination to be given this year.

A graduate program in space science financed by the National Aeronautics and Space Administration will begin next September at the University of Texas (Austin). NASA wants to encourage Ph.D. candidates in the fields of space and space-related subjects.

Some of the general research projects planned are spectroscopic analysis of planetary radiation, studies of extreme-temperature effects on structural materials, air purification in spacecraft, solar-energy power plants, and the crystal structures of rare-earth compounds.

Some specific Project Apollo-related activities will be temperature mapping and radar studies of the moon, design of temporary housing for use on the moon, and satellite motion in the vicinity of the earth and the moon.

"I am connected with the engineering and service divisions of a large corporation. I travel extensively so can't

attend night-school classes, but I'd like to work for a degree in mechanical engineering. Are there correspondence schools that offer college-accredited courses in mechanical engineering?" —G.C.L., San Francisco.

Generally you can't get a degree through correspondence courses alone. A number of colleges and universities in the country will allow one or two years of home study toward a degree, but no more. You should check this carefully with the dean of the college for any correspondence work.

The following colleges, accredited by the National Extension Association, do offer correspondence work in mechanical-engineering subjects.

University of Arkansas, Fayetteville.

Brigham Young University, Provo, Utah.

University of Colorado, Boulder.

University of Tennessee, Knoxville 16.

"I would like to work on research-and-development programs being carried out on advanced manned, lunar, and earth-orbital space projects. What kind of an education would I need? Where can I get it?" —C.W., Kansas City, Mo.

American space programs are so varied and so complex that they require large numbers of scientists, engineers, technicians, and craftsmen of all kinds.

In general, top research men require specialized education through the doctorate (Ph.D.), but they are assisted by large numbers of scientists and engineers with master's and bachelor's degrees, technicians who are graduates of technical institutes and similar programs, and countless others with a variety of practical and theoretical training. You can get

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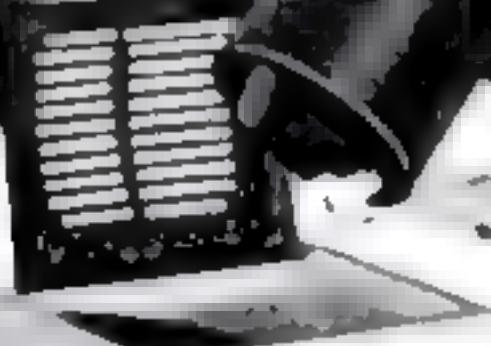
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a more complete picture from the following booklets:

Science and Your Career (Bureau of Labor Statistics, U.S. Department of Labor, Washington 25, D.C.).

How to Get into Science and Engineering (Science Service, 1719 N Street, N.W., Washington 6, D.C.).

Should You be a Scientist? (New York Life Insurance Co., Box 51, Madison Square Station, NYC 16.).

"I am a high-school sophomore and hope to become an executive pilot. How do I go about it?"—S.R., Santa Rosa, Calif.

Airline pilots with a flair for administrative work can move into supervisory and executive jobs, but the opportunities are limited. In any case, you first must become a pilot. Most scheduled airlines start their men as copilots, or sometimes flight engineers. "Beginners" usually are expected to have had between 500 to 1,000 flying hours and must meet rigid physical tests. Some airlines require at least two years of college, and prefer college graduates.

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"How or where can I get the complete picture on electronic engineering?"—E.D., Los Angeles.

I recommend the following publications:

Electronics—Career for the Future (Institute of Radio Engineers, Inc., 1 E. 79th St., NYC 21).

The Indispensable Man—The Electrical Engineer (American Institute of Electrical Engineers, 33 W. 39th St., NYC 18, 20 cents).

Send your questions on careers and technical training to:

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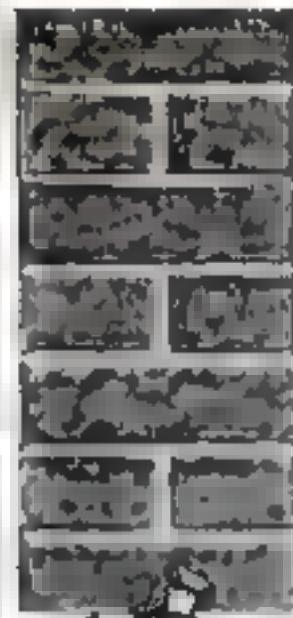
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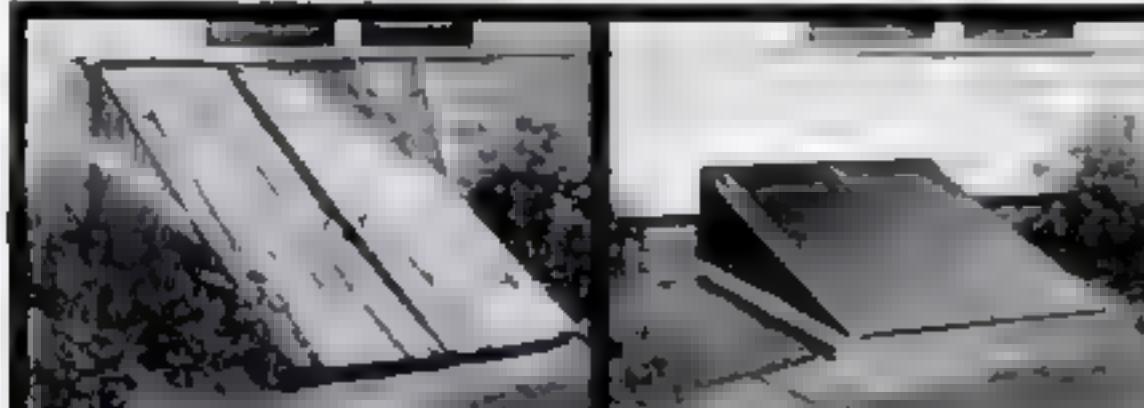
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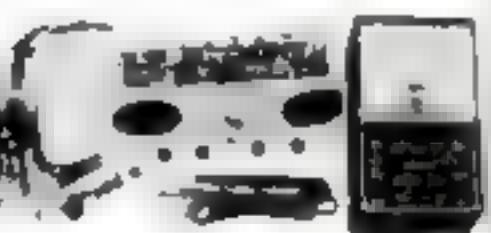
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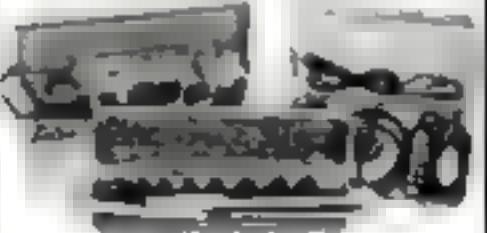
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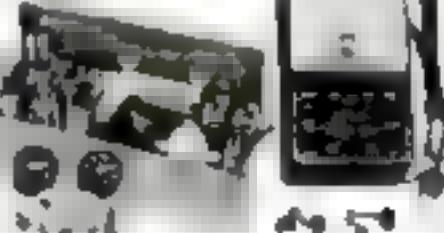
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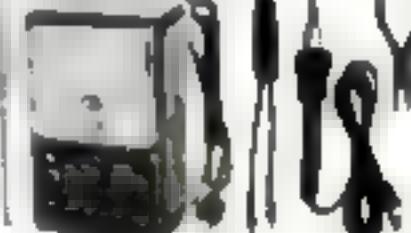
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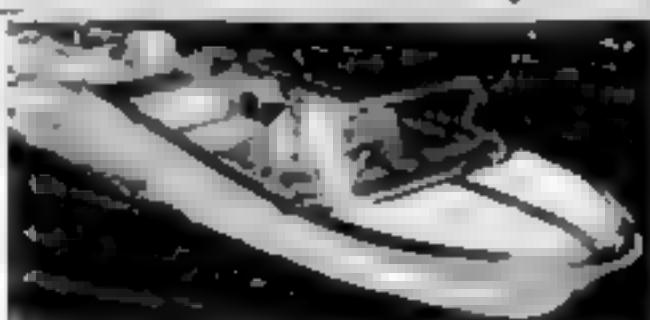
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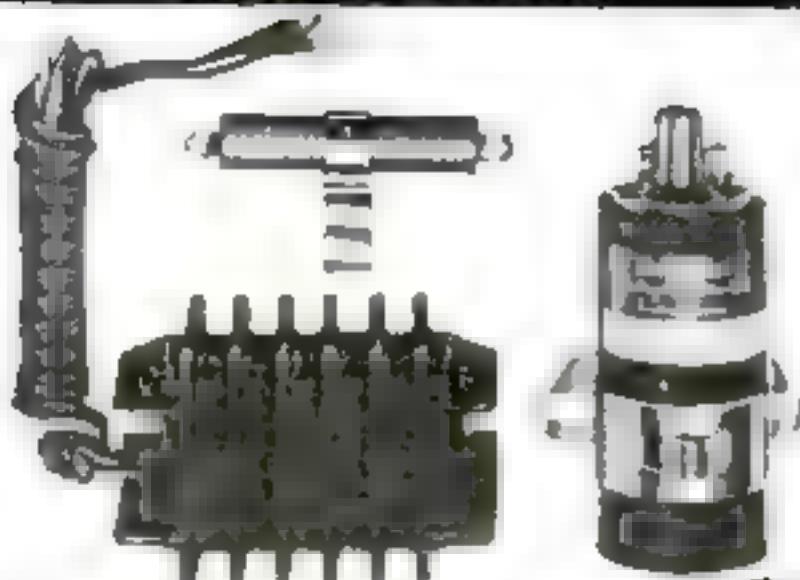
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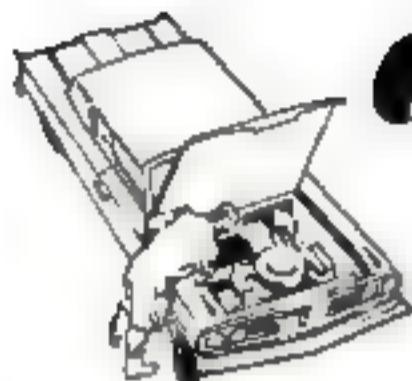
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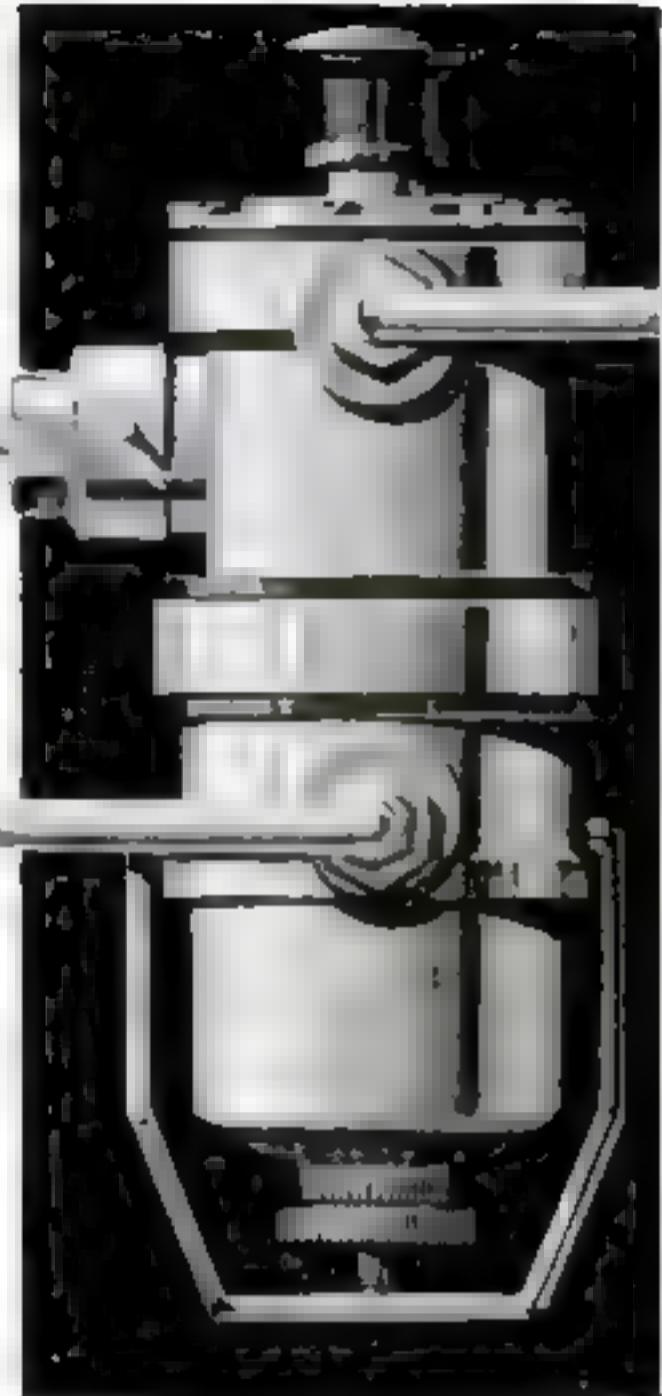
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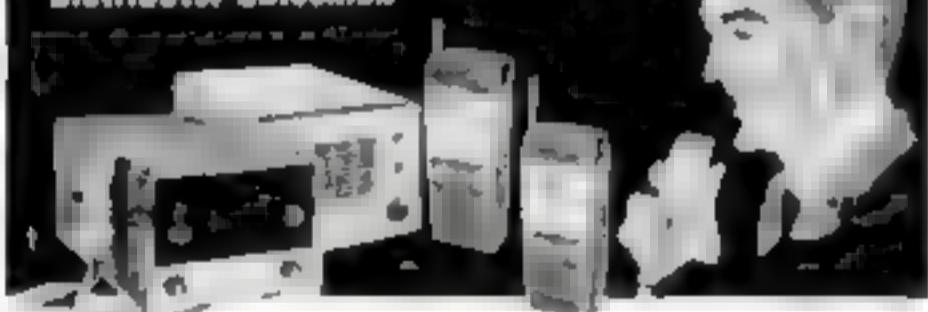


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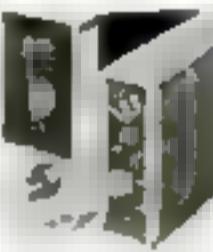
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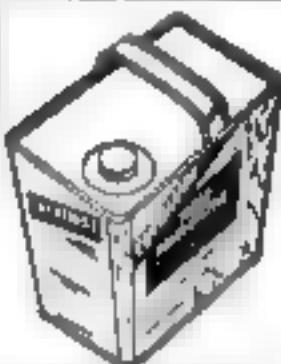
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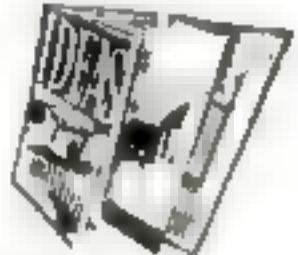
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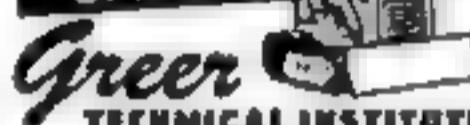


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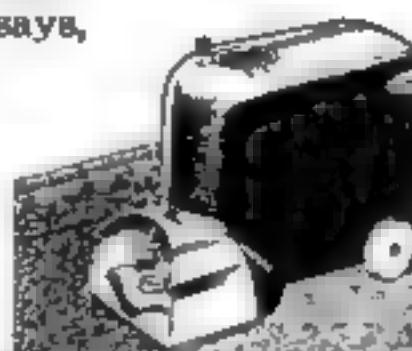
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Rattler with fangs bared lunges from hole as hunter pumps another shot home from a .22 gun.

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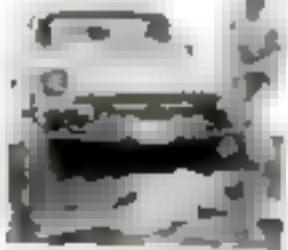
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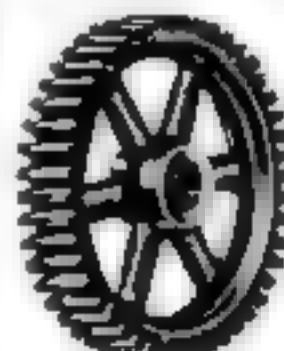
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Citroen	Humber	Opel	Toyopet
DAF	Jaguar	Peugeot	Vauxhall
Daimler	Lancia	Porsche	Volkswagen
DKW	Lloyd	Renault	Volvo
	Mercedes-Benz	Rover	
		Saab	

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Detroit report

By Devon Francis

Off to the races

Unless the signals are switched, three Ford-engined racing cars will be entered next month in the Indianapolis "500"—granddaddy of all U.S. auto races. The cars are being built by Lotus Cars, Ltd., in England, but Ford is being coy about who's sponsoring the entries. The engines are the V-8s that power the Falcon Sprint, sleeved-down from 260 cubic inches to the Indianapolis limitation of 256.2. With beefed-up crankshafts, the reported horsepower is a whopping 400 at 7,000 r.p.m.

Chevrolet engines will also compete at Indianapolis. Mickey Thompson, who built three cars powered by aluminum 256-inch V-8s (Buick's 215-incher bored out) for last year's Indy race, intends to enter four cars this year. These will have smaller-displacement aluminum versions of the Corvette 327-inch V-8.

Last year's Thompson entries looked impressive against the Offenhouser-engined cars until they were eliminated by mechanical trouble in the qualifying trials and the race proper. This year's cars, says Thompson, will weigh 100

Aluminum-lightened hot Dodge.



pounds less (about 1,100 pounds). The new engines are expected to be sturdier and more powerful.

Chrysler Corp. isn't planning to enter the Indianapolis race, but stock-car racing is something else again. To give

their RamCharger-powered Dodges and Plymouths an even bigger weight advantage over competition, they have introduced aluminum body parts that pare off 150 pounds. The limited-production factory-installed kit consists of front fenders, hood with an air scoop, stone and splash shields, and front bumper and supports. Price: \$350 complete.

Also, the battery in all RamCharger-equipped cars will be moved from the engine compartment to the right side of the trunk for improved traction.

More disk brakes are coming

At least five auto manufacturers are testing new disk brakes made especially for American cars by the Budd Co. One of the most interested is General Motors.

The new Budd brake is revolutionary in design: four lining pads instead of the customary two; a vented area in the center of the disk that reduces heat build-up. These features help eliminate some of the objections to disks that car manufacturers previously had. Eleven-inch versions of these disks can stop a 5,000-pound car, it's said.

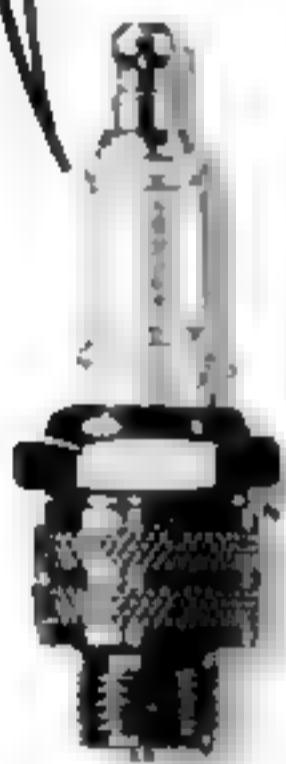
On the way for '64

The coming model year should see major retooling throughout the industry. Several cars, including the Buick Special, Olds F-85, and Pontiac Tempest, will definitely give up unitized construction. Chrysler Corp. may be returning to frame-body construction for several of their cars, too, although possibly not until 1965. Noise and vibration are said to be the main reasons for the switch.

Ignore any rumors that Chrysler may abandon its torsion-bar front suspension in favor of front coil springs, for its 1964 models, but look for a reappraisal of it by the company for 1965.

The entire Ford line should see big changes, too. The 1964 Lincoln will be lengthened four inches to increase interior room. It also will have unusual new tires that reportedly provide softer ride, longer life, and less rolling resistance. The 9.75-by-15 tires will have an extremely low profile.

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BUT AN
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while you drive. The spark plug with the longer firing tip that uses the heat of engine combustion to burn fouling deposits away. Drive in the city? Notice that a gallon of gas doesn't go as far as it used to? Guess what. You've got 'em. Deposits. If you're in no hurry to meet 'em again, just drive in and ask your dealer for Autolite Power Tip, the thrifty, long-lasting spark plug that actually cleans itself while you drive.

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1873 "An improved version of 'Hon-sen's Writing-Ball'—a writing machine introduced in the past season in the Copenhagen Exhibition and in London is now adapted to the purposes of copying as well.

"By interposing carbonized paper between the sheets and making all move together, several copies may be written or printed off at a single operation. It will thus perform the duty of several copying-clerks, and has also been found admirably suited to the work of writing out telegraphic dispatches."

"One of the newest uses for paper is to employ it as skins for sausages. This is of course a German notion, and Würtem-



burg is its birthplace. Unlike the skins commonly used, the paper envelope is not subject to fermentation, and is cleanliness itself."

1903 "Russian newspapers are of two classes: censored and uncensored. The former must show everything that is printed to a local censor beforehand. The latter are subject to the minister of the interior who suppresses them as he sees fit.

"Among the large number of forbidden subjects are news concerning disorders in the higher educational establishments or in factories and industrial works; information concerning the appearance of epidemic diseases or the spread of plague; and historical and critical articles in scientific journals which by reason of their content and distribution among a wide circle of readers might lead to undesirable results.

"A recent article in POPULAR SCIENCE MONTHLY concerning the heredity of the Romanof family was cut out of the issue

and the title on the table of contents inked out.

"We shall look forward with interest to learn whether the censor discovers this note and cuts it out of copies of the MONTHLY going to subscribers in Russia this month."

1933 "Radio fans witnessed a twentieth century marvel the other night when they listened to a radio program transmitted over a ray of light.

"An orchestra played before a microphone and a 50,000 candle-power searchlight sped the music to a studio window where a big lens caught the beam and concentrated it on a photoelectric cell so that the music could be picked up and broadcast.

"The main problem in talking over a light beam is in finding a source sufficiently sensitive to go on and off 10,000 times a second. A remarkable wireless lamp perfected by Elman B. Meyers is the answer. The lamp is an oddly shaped quartz tube eight inches long. When the tube is placed inside a high-frequency electric coil, a thimbleful of mercury within it turns to vapor and emits a dazzling blue light that may be flashed on and off 400,000 times a second!"

"Since the Versailles treaty forbids military aviation in Germany, potential war flyers get their gunnery training on the ground through ingenious expedients. One device employs an airplane wing mounted on a turntable controlled by a distant operator. It executes a dive while the gunner peppers it with bullets."



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Exact distance an entry goes on a gallon of gas is measured by fifth wheel on official car.

'Keep-'Em-Honest' Car Tests

By Hubert Luckett

How '63 models compared in

- **ECONOMY**
- **ACCELERATION**
- **BRAKING**

CAR tests have become a national rite rivaling bathing-beauty contests in their claim on public attention. "Stock" car races, cross-country runs, and a welter of other tests all produce results that makers of winning cars believe invaluable in persuading you to buy their latest model.

As often as not, however, these rituals are as much a test of men as of machines. A skillful driver or an



Premasured gallons of gas, stored in chipped ice until each contestant is ready to start, insure identical quantities.

CONTINUED

ingenious mechanic can make a difference in the outcome. And the preferences, prejudices, and limitations of the tester may color the results.

At the Daytona International Speedway in January, I witnessed a series of tests that are different. I believe the 1963 Pure Oil Performance Trials come closer to being an authentic comparison of the machinery you can buy from your car dealer than any public competition so far. Here's why:

- Inspection of the entries is merciless—unbelievably detailed, knowledgeable, and complete.
- Each of the trials—economy, ac-

celeration, braking—is designed to minimize the effect of driver skill.

● Timing and measurement, almost entirely automated, leave little room for human error.

● All trials take place on a closed circuit, with every move rigidly supervised by an army of NASCAR officials.

No stacked decks. I poked around behind the scenes for a week trying to find loopholes or soft spots that would allow a clever mechanic or a driving genius to win with a car unlike any you could buy. I found none. The factory reps, mechanics, and drivers I talked to, in general, agreed there weren't any.

CONTINUED



On the backstretch of each lap of the economy run, cars had to run at a true speed of 65

m.p.h. Speed zone was included to simulate average everyday driving conditions.



Automatic timer, actuated by a photocell set up beside the track, prints on a paper tape the exact time a car interrupts the light beam on each lap. The official timekeeper writes the



number of the car alongside each imprint. An overall average speed of 40 m.p.h. is required by test rules from the time the car takes off at the starting line until it rolls to a stop.



At the starting line, the car's regular fuel tank is disconnected and the remaining gas exhausted from the carburetor and fuel lines.



Special one-gallon tank on front door is connected by tubing to fuel pump and premixed fuel is poured in immediately before start.

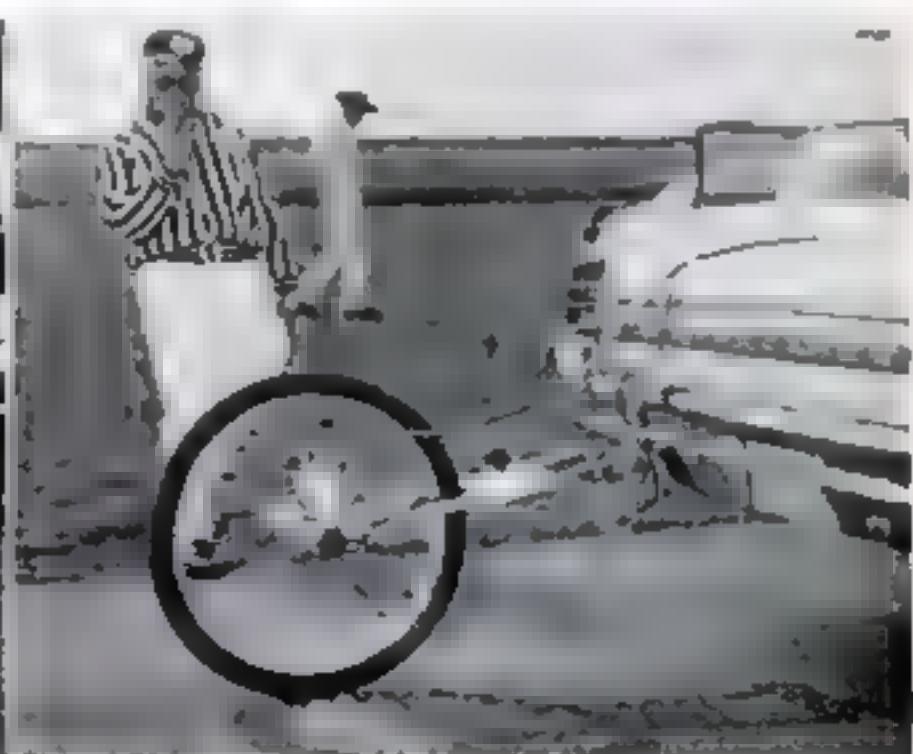


Complete stop on every full lap is required. Cars with standard synchromesh transmissions

may not de-clutch before reaching this sign placed 75 feet from the stop line.



Riding observer marks paving to show position of the front wheel when car rolls to a stop after exhausting its one gallon of fuel. Car is then pushed off the track by hand.

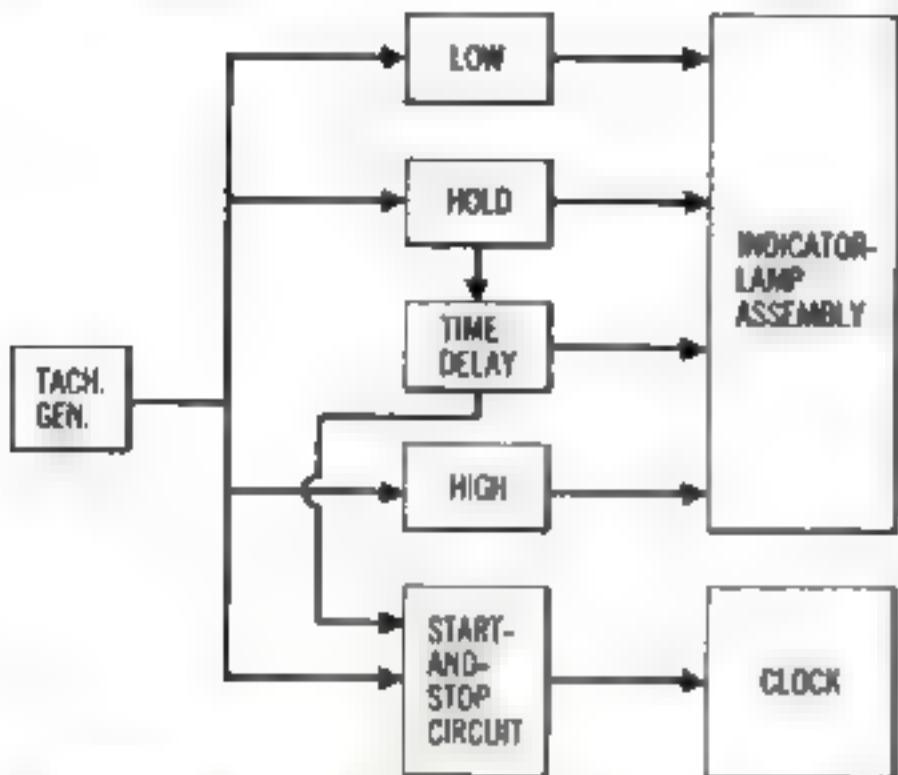


Fifth wheel measures the distance from the last surveyed marker on the track to the observer's chalk mark, to tell the exact distance the car covered on its single gallon of gas.

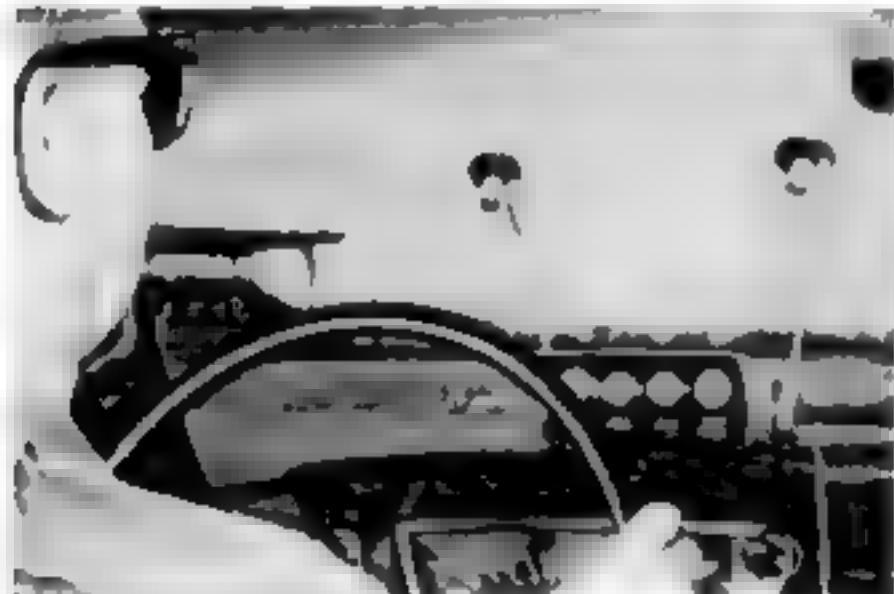
How They Ran

							ECONOMY	ACCELERATION	BRAKING									
CLASS	CAR NO.	CAR NO.	TOTAL POINTS EARNED	ENGINE TYPE	DISPLACEMENT (cu. in.)	CARBURETOR	HORSEPOWER	TRANSMISSION	M.P.G.	POINTS (mpg)	PENALTY (mpg)	TIME (sec.)	POINTS	PENALTY (sec.)	STOPPING DISTANCE (feet)	POINTS	PENALTY (feet)	TOTAL POINTS
CLASS I	FORD GALAXIE 300	1-8	20	V-8	427	2 4-bbl.	425	3-spd. o.d.	14.27	5	5.296	7	184.1	8				38
	FORD GALAXIE 300	1-7	18	V-8	406	3 2-bbl.	405	3-spd. o.d.	14.08	4	5.858	5	178.3	9				
	PLYMOUTH BELVEDERE	1-9	15	V-8	426	2 4-bbl.	415	4-spd.	14.34	6	5.308	6	249.7	3				36
	PLYMOUTH BELVEDERE	1-10	21	V-8	426	2 4-bbl.	415	4-spd.	16.13	8	5.005	8	217.3	5				
401 to 450 cu. in. Heavy V-8 engines	PONTIAC CATALINA	1-11	17	V-8	421	1 4-bbl.	405	4-spd.	8.53	0	4.879	10	189.4	7				36
	PONTIAC CATALINA	1-12	19	V-8	421	1 4-bbl.	405	4-spd.	9.39	0	4.950	9	174.2	10				
	CHEVROLET IMPALA	1-3	12	V-8	409	1 4-bbl.	400	4-spd.	13.36	2	5.890	4	191.3	6				21
	CHEVROLET IMPALA	1-4	9	V-8	409	1 4-bbl.	340	4-spd.	16.49	9	8.328	0		0				
	BUICK LE SABRE	1-1	7	V-8	401	1 4-bbl.	325	auto.	13.92	3	8.455	0	222.6	4				17
	BUICK WILDCAT	1-2	10	V-8	425	1 4-bbl.	340	4-spd.	15.08	7	7.488	1	255.6	2				
	CHRYSLER 300	1-5	12	V-8	413	1 4-bbl.	360	3-spd.	17.38	10	7.296	2	299.1	0				17
	CHRYSLER 300	1-6	5	V-8	413	1 4-bbl.	360	3-spd.	11.10	1	6	7.203	3	258.1	1			
CLASS II	FORD GALAXIE 300	2-1	21	V-8	390	1 4-bbl.	330	3-spd. o.d.	16.02	6	7.402	6	183.6	9				42
	FORD GALAXIE 300	2-2	21	V-8	390	1 4-bbl.	330	3-spd. o.d.	16.07	7	7.963	4	169.5	10				
	PLYMOUTH BELVEDERE	2-6	20	V-8	383	1 4-bbl.	330	4-spd.	15.24	5	6.298	9	209.9	6				41
	PLYMOUTH BELVEDERE	2-7	21	V-8	383	1 4-bbl.	330	4-spd.	17.17	8	6.667	8	216.2	5				
362 to 400 cu. in. Large V-8 engines	PONTIAC CATALINA	2-8	27	V-8	389	3 2-bbl.	313	4-spd.	18.12	9	6.200	10	190.5	8	20			37
	PONTIAC CATALINA	2-9	10	V-8	389	3 2-bbl.	313	4-spd.	18.55	10		0		0				
	OLDSMOBILE STARFIRE	2-4	14	V-8	394	1 4-bbl.	345	auto.	14.97	3	7.345	7	277.4	4	20			
	OLDSMOBILE STARFIRE	2-5	16	V-8	394	1 4-bbl.	330	auto.	15.11	4	7.445	5	206.6	7				30
	MERCURY MONTEREY	2-3	5	V-8	390	1 4-bbl.	250	auto.	12.49	2	12.470	3	**	0			5	
CLASS III	CHEVROLET BEL AIR	3-1	24	V-8	327	1 4-bbl.	300	4-spd.	18.04	9	7.885	8	180.5	7				49
	CHEVROLET BEL AIR	3-2	25	V-8	327	1 4-bbl.	250	4-spd.	20.08	10	8.941	7	176.6	8				
	PONTIAC TEMPEST	3-4	19	V-8	326	1 4-bbl.	280	3-spd.	16.20	5	7.032	9	196.3	5	20			44
	PONTIAC TEMPEST	3-5	25	V-8	326	1 4-bbl.	280	3-spd.	16.67	6	6.585	10	174.9	9				
321 to 361 cu. in. medium V-8 engines	RAMBLER AMBASSADOR	3-6	18	V-8	327	1 4-bbl.	270	3-spd. o.d.	17.60	7	10.743	5	180.7	6				42
	RAMBLER AMBASSADOR	3-7	24	V-8	327	1 4-bbl.	270	3-spd. o.d.	17.97	8	9.886	6	167.5	10				
	DODGE 800	3-3	12	V-8	361	1 2-bbl.	265	auto.	15.24	4	11.244	4	224.0	4				32
CLASS IV	PLYMOUTH BELVEDERE	4-5	26	V-8	318	1 2-bbl.	230	3-spd.	23.37	10	9.966	10	201.5	6				51
	PLYMOUTH BELVEDERE	4-6	25	V-8	318	1 2-bbl.	230	3-spd.	23.08	9	10.325	9	189.8	7				
	CHEVROLET BEL AIR	4-1	25	V-8	283	1 2-bbl.	195	3-spd. o.d.	22.23	8	11.045	8	182.1	9				47
	CHEVROLET BEL AIR	4-2	22	V-8	283	1 2-bbl.	195	3-spd.	21.03	7	11.259	7	186.4	8				
259 to 320 cu. in. Small V-8 engines	FORD FAIRLANE	4-3	15	V-8	260	1 2-bbl.	164	3-spd. o.d.	20.20	6	13.318	4	208.4	5				35
	FORD FAIRLANE	4-4	20	V-8	260	1 2-bbl.	164	3-spd. o.d.	20.19	5	13.223	5	176.7	10				
	STUDEBAKER AVANTI	4-7	10	V-8	289	1 4-bbl.	280	auto.	16.12	4	11.270	6	0				10	
CLASS V	PLYMOUTH VALIANT	5-10	15	S-6	225	1 2-bbl.	145	3-spd.	24.56	8	13.715	5	208.0	2				36
	PLYMOUTH VALIANT	5-11	21	S-6	225	1 2-bbl.	145	3-spd.	25.40	10	12.373	6	184.5	5				
	BUICK SPECIAL	5-1	16	V-8	215	1 4-bbl.	200	4-spd.	22.32	4	9.623	9	206.2	3	20			33
	BUICK SPECIAL	5-2	17	V-8	215	1 4-bbl.	200	auto.	22.56	6	10.971	7	185.1	4				
201 to 258 cu. in. Large 6-cylinder and compact V-8 engines	OLDSMOBILE F-85	5-8	20	V-8	215	1 4-bbl.	185	4-spd.	22.35	5	9.345	8	178.0	7	20			32
	OLDSMOBILE JETFIRE	5-9	12	V-8	215	1 1-bbl. S	215	4-spd.	20.26	1	8.828	10	211.3	1	20			
	FORD FAIRLANE	5-6	16	V-8	221	1 2-bbl.	145	3-spd. o.d.	20.44	3	16.375	3	158.2	10				30
	FORD FAIRLANE	5-7	14	V-8	221	1 2-bbl.	145	3-spd. o.d.	20.42	2	15.589	4	169.2	8				
201 to 258 cu. in. 6-cylinder and compact V-8 engines	CHEVROLET BISCAYNE	5-3	8	S-6	230	1 1-bbl.	140	3-spd. o.d.	24.02	7	17.008	1	252.4	0				28
	CHEVROLET BISCAYNE	5-4	20	S-6	230	1 1-bbl.	140	3-spd. o.d.	24.71	9	16.613	2	162.9	9				
	DODGE DART	5-5	6	S-6	225	1 1-bbl.	145	auto.	15.24	0	5.7	19.083	0	181.0	6			6
CLASS VI	PONTIAC TEMPEST	6-8	21	4	195	1 4-bbl.	166	4-spd.	23.54	4	10.465	10	165.4	7				34
	PONTIAC TEMPEST	6-9	13	4	195	1 4-bbl.	166	4-spd.	22.54	0	10.857	9	175.8	4				
	RAMBLER AMERICAN	6-10	10	6	195</td													

ACCELERATION



Electronic brain-box is shown here in a block diagram. One group of circuits controls signal lights in front of driver; another controls the clock. It's programmed with five dials.

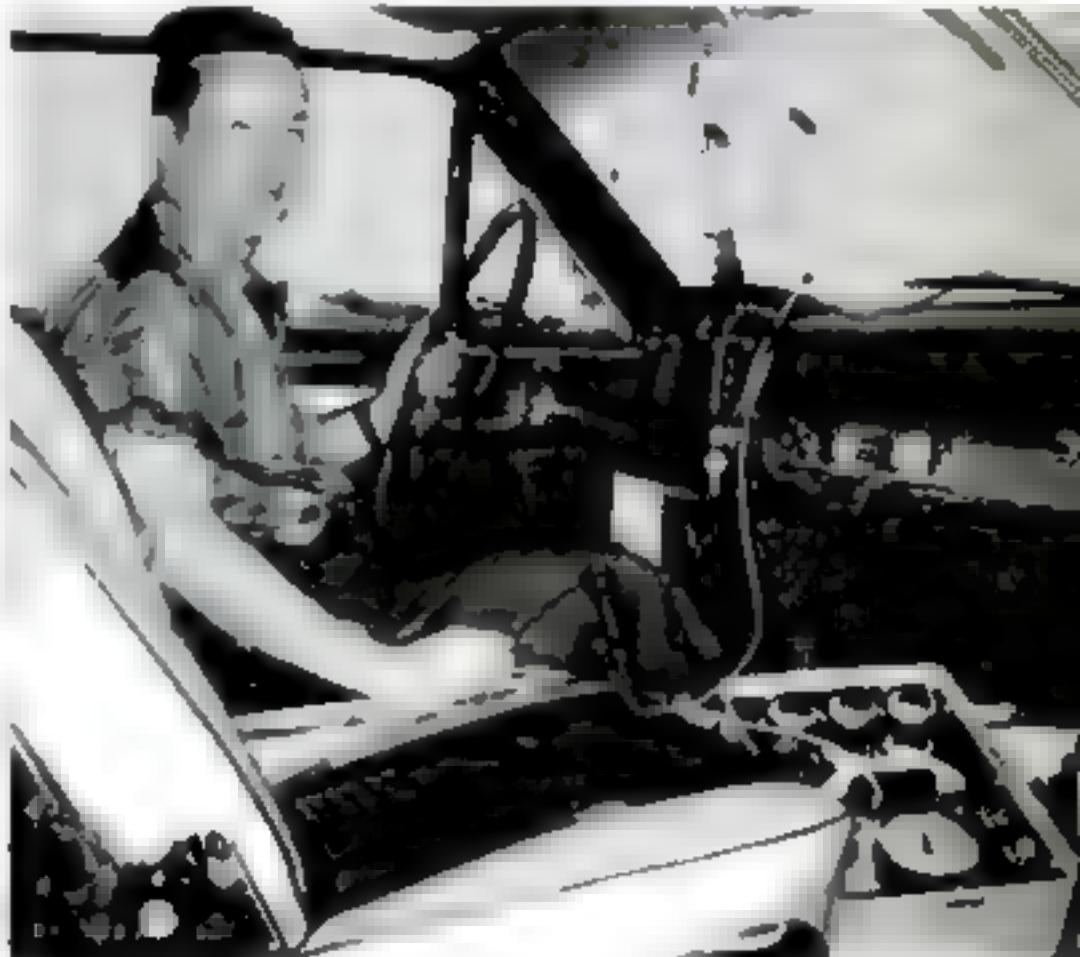


Colored lights in a box in front of driver tell him when he has leveled off and is driving at the proper speed (22-24 m.p.h.) to start acceleration run. When the green light is holding steady he steps on accelerator. When speed passes 25 m.p.h., timer clock starts automatically and runs until speed reaches a true 70. Official riding observer records elapsed time.

Some of them had to be convinced the hard way: Four entries were ordered to install completely new engines; several had to replace entire rear-end assemblies; about half had to replace all their valve springs. Cylinder heads, carburetors and carb jets were among other items challenged by the inspectors for not conforming to manufacturers' published AMA specifications. Five non-stock camshafts were discovered, and only one out of 10 carburetors was found



Voltage output of the generator on fifth wheel is accurately proportional to speed, within one percent, from 0-100 m.p.h. Final fine calibration is done by varying air pressure in tire.



to have the factory-specified float setting.

A fantastic 16,600 man-hours went into the precompetition inspection. The engines of all 57 cars entered were disassembled and each part measured, weighed, flow-tested, or otherwise checked to make sure it corresponded precisely to specifications. One carburetor jet that appeared stock and measured correctly was found to give an incorrect flow rate when tested on a flow



Brain-box for braking test turns on ready light at 60 m.p.h. When brake is applied, stoplight switch on brake starts electronic counter, which runs until car stops.

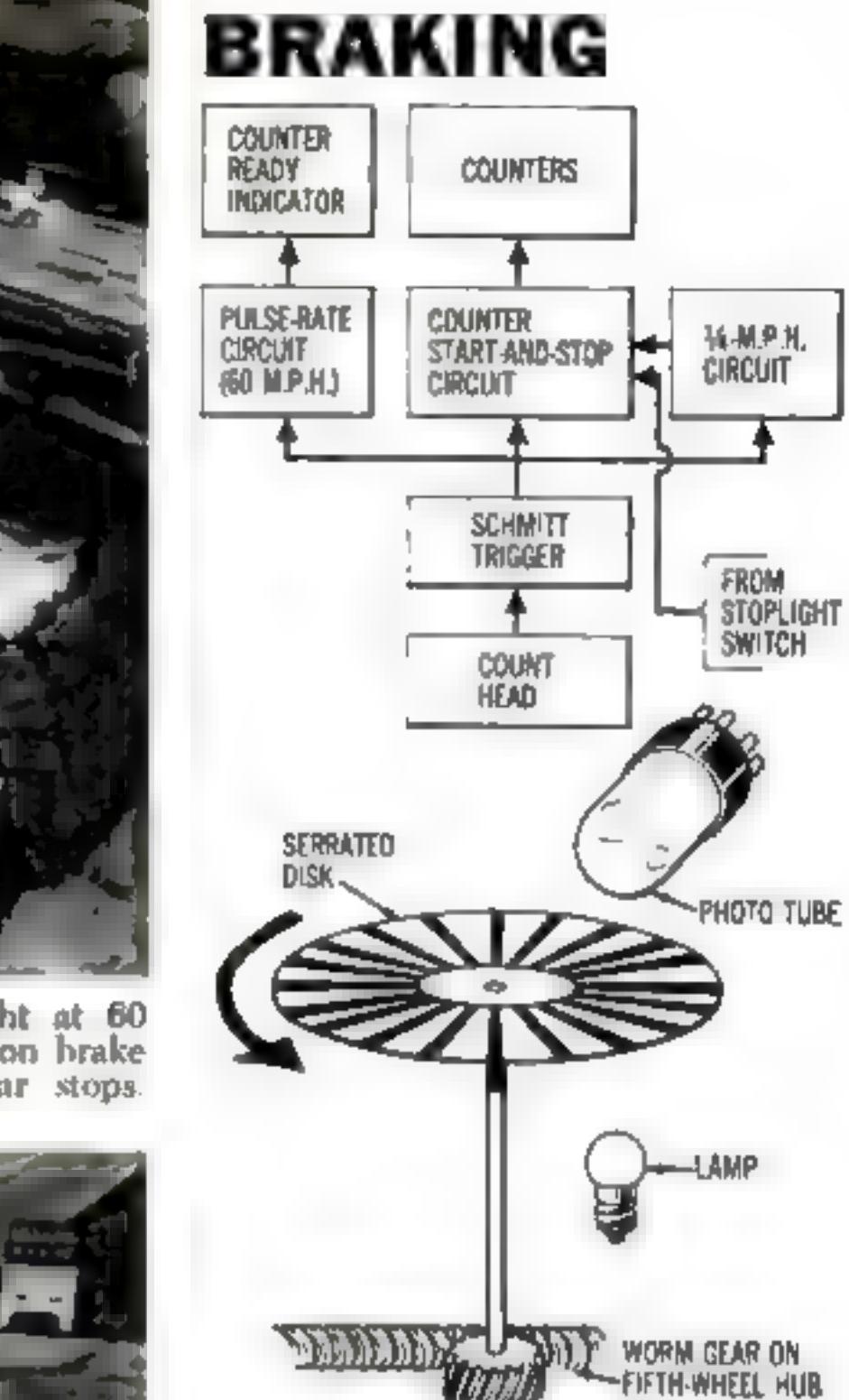


Before final panic stop from 60 m.p.h. (the one that's measured), each car makes 21 stops in rapid succession.

bench. Inspection with a magnifying glass revealed that the tip had been peened slightly to restrict the flow.

The official attitude is that variations from specs are the result of production-line variations or accidents. And, indeed, many of the off-standard items would have handicapped a car's performance. But, accidental or intentional, there seem to be no loopholes NASCAR's inspectors haven't plugged.

Eyeing the cars. They check the voltage regulator to be sure it hasn't been backed off to lessen the generator load; measure cooling-water flow—a water pump can be gimmicked to pump less



Count head on fifth wheel uses striped disk (actually a photo negative) to interrupt beam of light shinning on photocell a fixed number of times for each revolution of the wheel. Electronic counter counts resulting electrical pulses and displays numerical read-out of braking distance.

and therefore sap less engine power. Thermostat-opening temperature is measured—an engine burns less gas at higher temperatures. Fan-belt tension is checked—if the belt slips, it's not pulling the full generator and water-pump load. They guard against the ancient slashed—or thrown-fan-belt trick by sealing the hood for each run. Any car without a fan belt at the end of a run is disqualified.

The cars are weighed to catch concealed use of aluminum or fiberglass to replace standard steel parts. Tires are carefully inspected (some premium-

[Continued on page 210]

NOW that man has taken his first step into space through orbital flight, the stage is set for an even greater adventure. That will be the conquest of "cislunar" space—the space this side of the moon.

What's it like out there? Is space really "empty"? What is the solar wind? What new risks will astronauts encounter in the radiation fields that encircle the earth?

To learn the answers to such questions, POPULAR SCIENCE sought out a top authority — Dr. James A. Van Allen, head of the physics department at the

State University of Iowa. He is the discoverer of the earth's invisible radiation belts—and also their proprietor, according to President Kennedy. (Last year, during scientific controversy preceding the high-altitude hydrogen-bomb blast set off July 9, Kennedy quipped: "I know there's been a disturbance about the Van Allen belt, but Van Allen says it's not going to affect the belt, and it's his.")

I found Dr. Van Allen in Boston, at Massachusetts Institute of Technology, where he was conferring with other space scientists. That evening, over dinner, I asked him about newly discovered phenomena of "empty" space. "Most people still think of space as a cold, black vacuum," I said. "Is it true that scientists shared this misconception until very recently?"

"Most scientists did think of space as a barren waste," he said. "When we started getting real information, it was quite a revelation.

MAN

IS

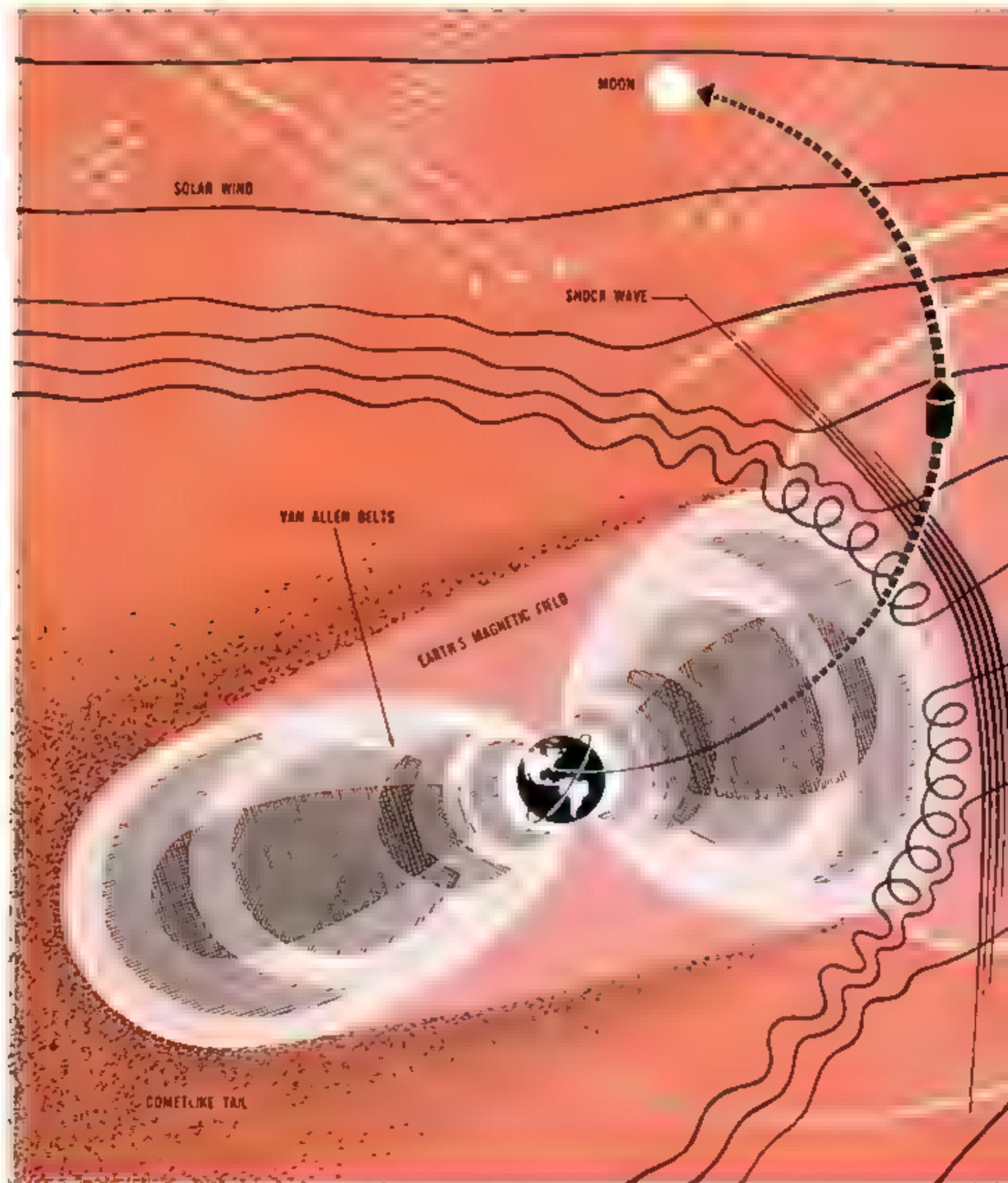
JAMES ALLEN TELLS WHAT SPACE REALLY LIKE

An exclusive interview
with the discoverer of the
earth's radiation belts,
by Popular Science Senior
Editor Wallace Cloud



How Van Allen sees the invisible contents of far-from-empty space

A sea of energy, space is aptly shown colored, inst. ad of usual black void. Black lines radiating from the sun stand for steaming plasma of the solar wind, which compresses the earth's magnetic field, a shock wave and tur-

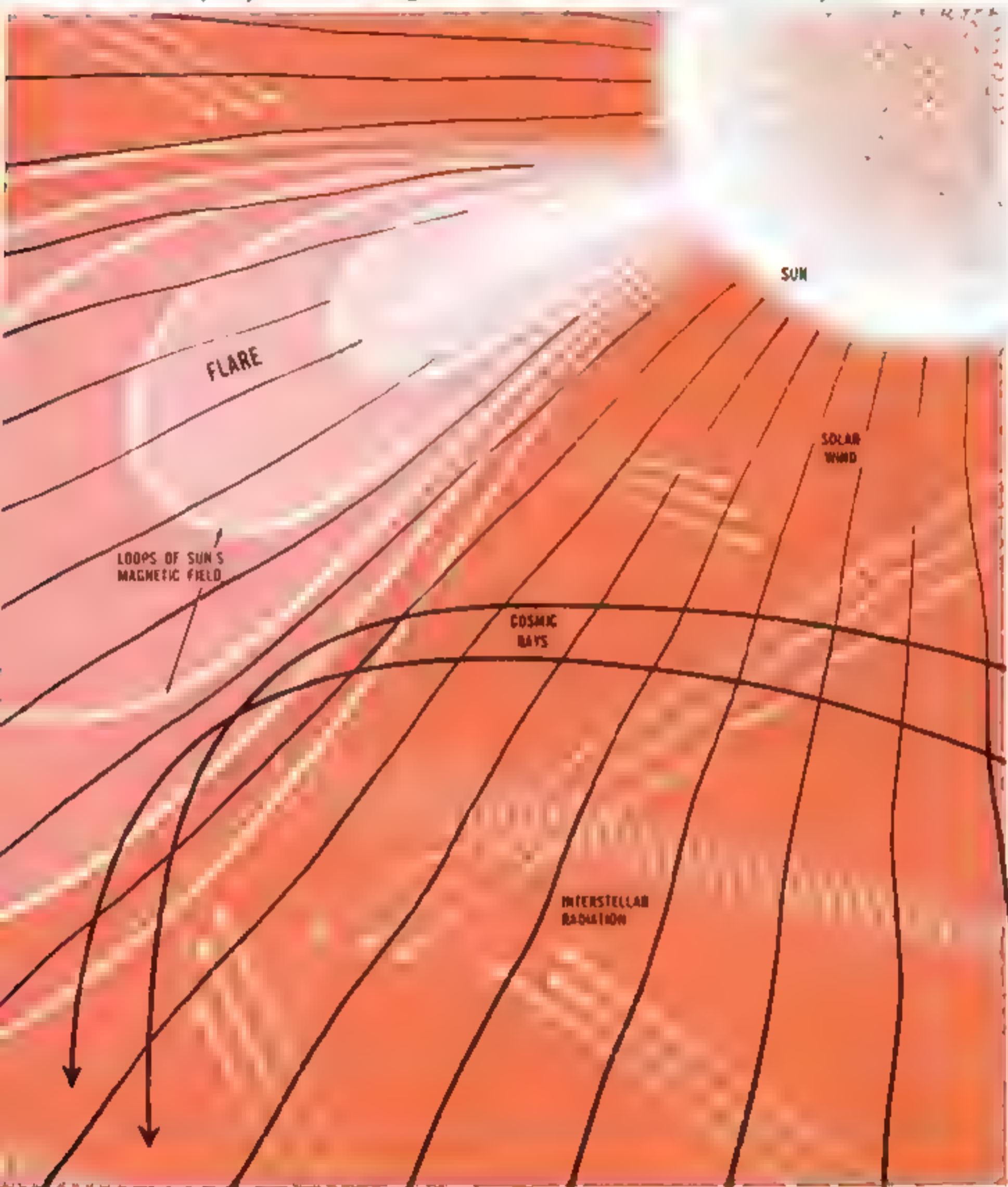


"Perhaps I can give you an idea of how we felt when we discovered the radiation belts. In 1958, when Explorer III was in orbit, we had a counter aboard to register cosmic-ray particles. The data

we got back was puzzling. Radiation increased up to 500 or 600 miles out, then dropped sharply to zero. When we realized that the counter was too sensitive—that it simply got overloaded and jammed

bulence occur where they meet, and wind gives earth a cometlike tail of dust and gas. So far, manned space flights have been safe inside Van Allen belts, but moon ships must traverse radiation zone, may encounter dangerous solar

flares. Flare hurls high-energy plasma, moving so fast it carries along loops of sun's magnetic field, which can deflect cosmic rays. Space also contains interstellar radiation of many kinds from sources outside solar system.



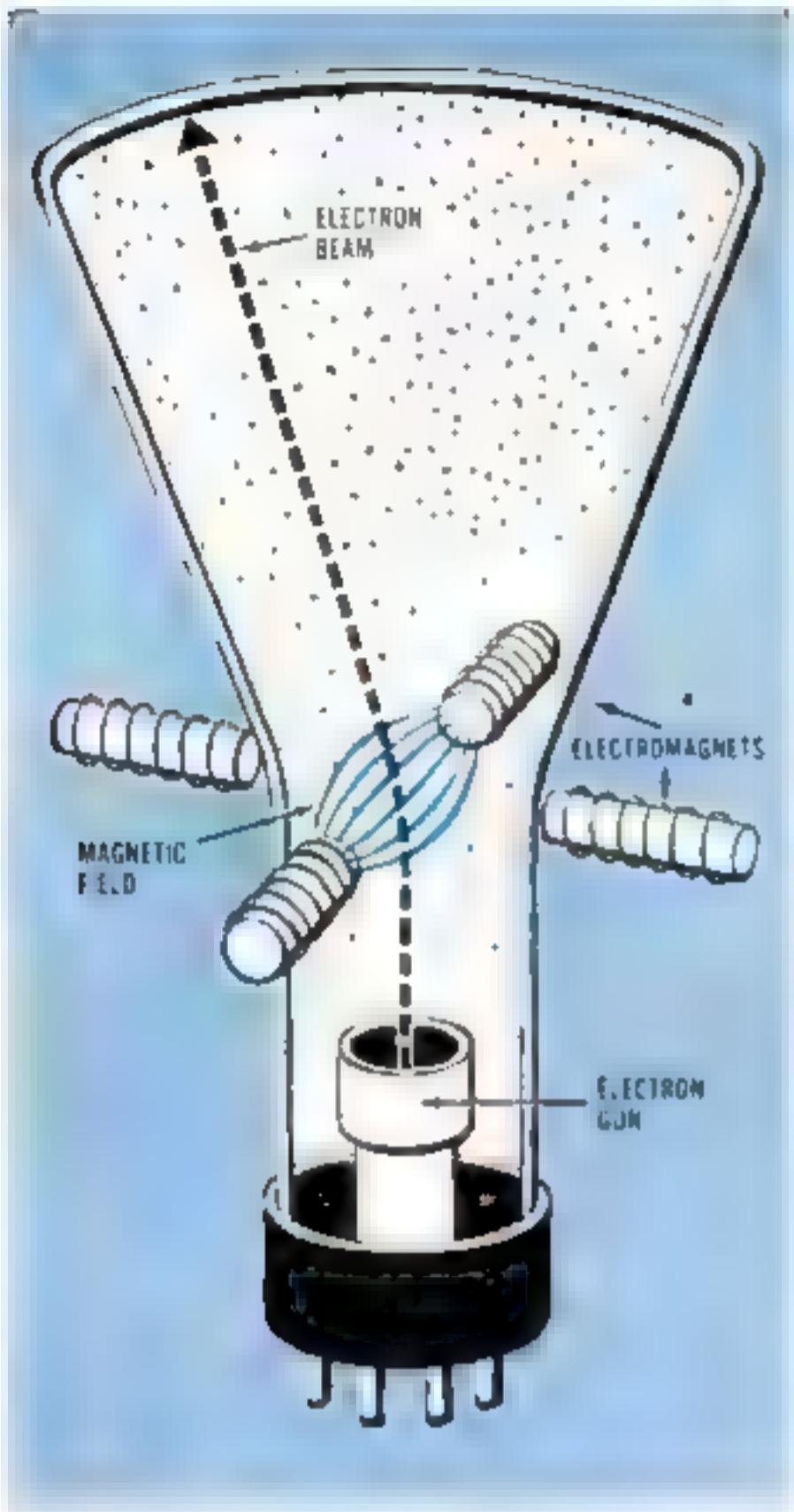
—one of the boys, Ernest Ray, exclaimed: "Space is radioactive!"

This brought up the radiation hazards of space flight. So far, men have orbited safely inside the Van Allen belts, but

getting to the moon involves going straight through them.

The artificial belt created by last summer's bomb test is no problem, Dr. Van Allen said, since it will have disappeared

"Space" was invented on earth before we knew what was out there



Space in a bottle: In ordinary TV picture tube, electron beam is aimed by electromagnets to make it scan face of tube, simulating the way magnetic fields deflect particles in space. Conditions of outer space (plasmas, radiation, magnetic effects) occur in many electronic devices. But energies are much higher in space, plasma is much thinner than in man's inventions.

by this summer. Even so, a one-way trip through the natural belts "on a hot-dash escape basis" will expose an astronaut to about 10 roentgens of radiation—a lot in terms of normal radiation tolerances on earth.

"But in a high-risk mission like space flight, that much radiation isn't taken too seriously," he said. About 400 roentgens would be a dangerous exposure.

Making one or more round trips doesn't increase the risk, he explained,

since radiation sickness isn't cumulative. "Certain effects do build up, of course—such as genetic effects. It would be advisable for an astronaut to have a family already before traveling back and forth through the belts."

"How many belts are really out there?" I asked. "Some people speak of one Van Allen belt, but originally you discovered two of them. And recently some scientists have been talking about a single 'magnetosphere.'"

"The magnetosphere is the region in which the earth's magnetic field dominates space," Dr. Van Allen said. "The two original belts are quite distinct within this zone. But the fact is that you can map almost any number of belts, depending on what kind of particle you're interested in."

I had read in a news story that the artificial belt was created by approximately a pound of electrons, injected into the earth's magnetic field by the hydrogen-bomb explosion. I asked Dr. Van Allen if that estimate was correct.

"Actually, that's high," he said. "The amount was more like one milligram of electrons."

That's $1/28,000$ of an ounce of matter. It had caused an international controversy and created a new belt with very real physical effects (including damage to satellites, perhaps even the failure of Telstar). "Well, then," I asked, "how much matter is there in the natural radiation belts?"

"A few grams," said Dr. Van Allen. "But that doesn't give you any idea of the tremendous energies involved. In space, energy is really in command."

"What's the source of the energy? Where do the particles come from?"

"We're almost certain the particles come from the solar wind," he said.

He explained that the solar wind consists of matter being ejected from the sun by the force of repeated thermonuclear explosions. This material is mostly hydrogen, plus some helium and a

[Continued on page 206]



CULVER PICTURES

Columbia University researchers take a look at your driving habits—and come up with some startling findings

Slow Drivers Can Kill You

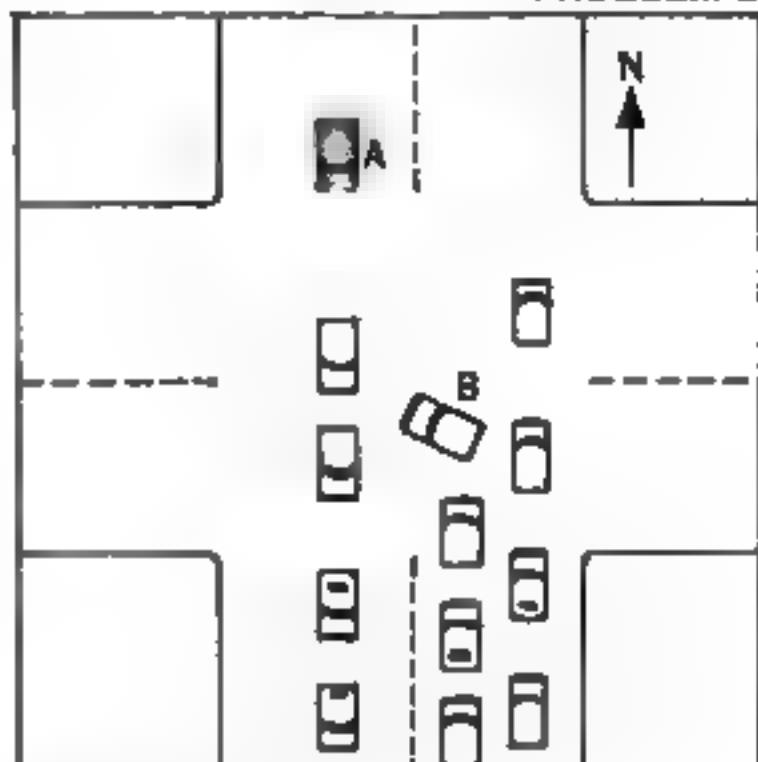
By Martin Mann

THIE cops may be handing out tickets to the wrong guys. *Slow* drivers could be the bad drivers. In fact, they might even kill you.

That is just one revolutionary conclu-

sion that Columbia University researchers have drawn from a two-year study. If their report, just released, stands up, the entire art of driving is due for a shake-up. The findings also suggest how you can be a better driver yourself in ways you probably never thought of.

CONTINUED

PROBLEM B

How Good a Driver Are You?

Your answers to the questions below and on the facing page reveal your driving habits, say Columbia psychologists. These are samples from a long test designed to separate good drivers from bad. (Correct answers are given below, at right.)

The situation:

You are in Car A passing Car B. When you are only a few feet behind B, he starts into left lane.

You should:

- 1 Sound your horn and keep going.
- 2 Move left and accelerate to pass B.
- 3 Slow down to let B enter passing lane.
- 4 Move quickly to right-hand lane.

PROBLEM A

The situation:

You are heading south in Car A, approaching an intersection. Car B on the northbound side is waiting to make a left turn. Southbound traffic apparently has prevented him from completing his turn. Several cars are now immobilized behind him.

You should:

- 1 Accelerate to get across the intersection as fast as possible.
- 2 Proceed at your same speed.
- 3 Slow down slightly just in case the driver trying to make the left turn decides to cut in front of you.
- 4 Stop short of the intersection and let the other driver turn left.

The Columbia report contradicts some of the most hallowed beliefs about driving. For example, the researchers maintain that:

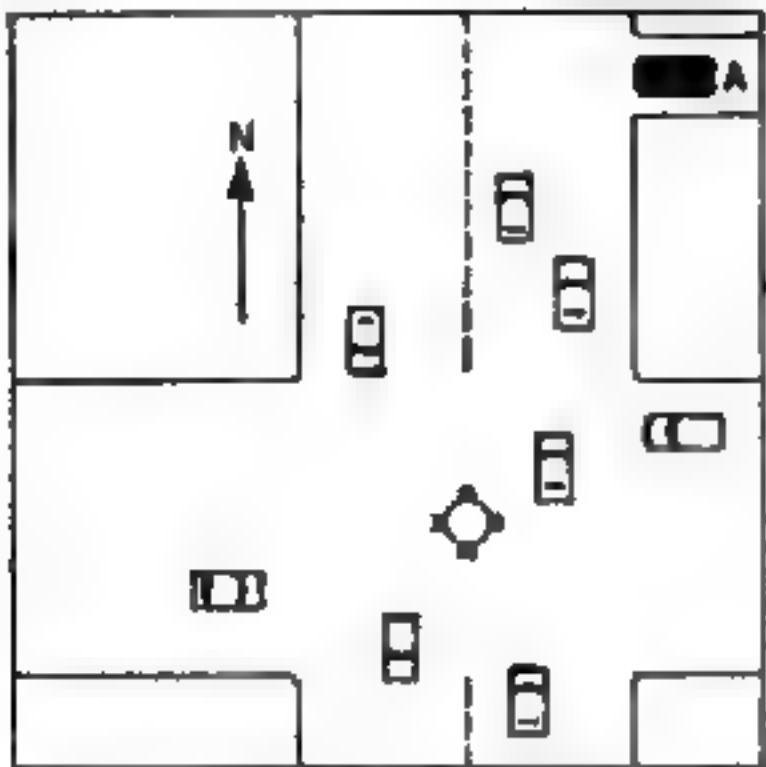
- Fast drivers, even reckless drivers, are not as dangerous as some other kinds.
- Breaking the rules is a good idea—sometimes.
- Bullying ahead, taking advantage of every opening without hesitation, may be safer—for some drivers in some vehicles.
- Defensive driving—trying to anticipate the other guy's mistakes—may not be the best way to drive.

These ideas grew out of a search for characteristics of good and bad drivers by the Safety Research and Education

Project at Columbia's Teachers College. The study was financed by the American Automobile Association Foundation for Traffic Safety and the U.S. Public Health Service. Here's how the project's director, Dr. James L. Malfetti, describes the characteristics of the genuinely good driver:

"We found that the good driver always keeps the cars around him in mind. He helps traffic flow smoothly, and never gets in the way. More, he does what other drivers expect him to do."

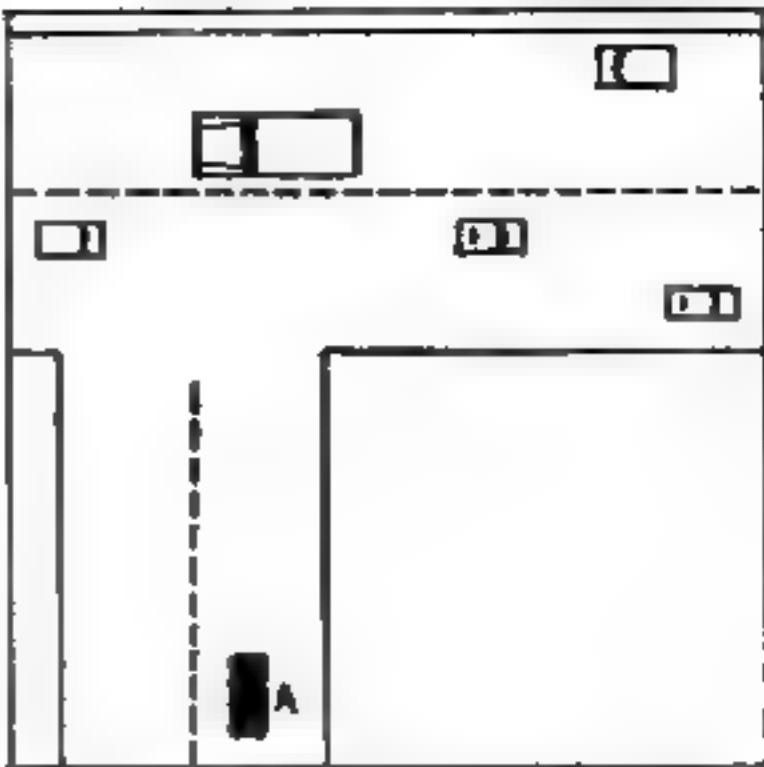
"The bad driver acts as if he has the only car on the road. He pokes along too slow for the traffic or clogs a fast lane. He hesitates at turns and intersections, so that you can't tell whether he means to go first or let you go first. He's either

PROBLEM C**The situation:**

You are in Car A in a driveway, pointed toward the road. The intersection, left, has a traffic light. You wish to go south. Northbound traffic is moderate, southbound light.

You should:

- 1 Wait until north-south traffic is stopped for a red light; then proceed carefully to cross the northbound lanes and turn left.
- 2 Make a right turn, drive north for a short distance, and when convenient make a U-turn to head south.
- 3 Slowly inch out until the northbound cars are forced to stop for you.
- 4 Signal for a left turn and cross quickly into the southbound lane.

PROBLEM D**The situation:**

You are in Car A driving down a side road toward a highway. You are slowing down and signaling for a left turn. Directly ahead of you, you see truck B stopped on the highway and signaling for a left turn.

You should:

- 1 Attract the truck driver's attention to see if he will allow you to make the turn before he does.
- 2 Keep in your present lane and come as far forward as possible before stopping at the intersection.
- 3 Concentrate on your turn. The truck driver should courteously wait.
- 4 Stop one or two car lengths short of the intersection.

unaware of cars around him, or he just doesn't care. He gets in the way and sets up accidents."

What's bad about the defensive driver?

Dr. Malfetti says: "He expects the other fellow to act stupidly or belligerently, and tries to outsmart him. Driving a car is complex enough without trying to outsmart other drivers."

Breaking rules is one mark of the good driver, Dr. Malfetti claims—when it's done at the right time in the right place. He cites this example:

A car straddles the white line right in the middle of the road and slows down. Stupid? No. Smart. He sees a road-block ahead that the cars following him cannot see. If he slowed in his lane, the others would pass him and pile into

trouble. By straddling lanes, the motorist compels everybody to slow for a stop.

Dr. Malfetti will not say that fast, hard driving is good. He does believe it is nowhere near as deadly as preachers of the "Go Slow, Be Careful, Speed Kills" doctrine make out. Here's why:

The leadfoot. The fast driver makes himself obvious. Everybody recognizes him and keeps out of his way. Because his actions are clear and expected, he is not so likely to cause trouble.

[Continued on page 209]

Answers to Driving Problems

"Good" drivers choose these options: Problem A-3; Problem B-4; Problem C-1; Problem D-4.



"Into the water" is signal for firemen to dive in with equipment. Buoyant balsa blocks are strapped on hose, form collar behind nozzle.



Jet-propelled doodlebug spraying tons of water upward is guided into midst of blaze. Scuba firemen dive underwater in case of danger.

Frogmen fight dock fires under water

The Los Angeles Fire Department now has a skindiver division—the first in this country. Responsible for 19 miles of harbor docks, it's an important adjunct to the fireboat brigade. Tangled mazes of tar-and creosote-soaked timbers, pilings, and docks burn fiercely giving off an acrid smoke that hides the fire from hosemen, and deflect water directed from above.

The Scuba firemen hit them from below. Rubber-suited and equipped with underwater breathing apparatus, they are pro-

tected from both heat and choking smoke. Standard 1½- and 2½-inch hose is still the firemen's favorite weapon, but the frogmen have added some new wrinkles. Blocks of balsa wood are lashed to the hose for buoyancy and the nozzles are thrust through balsa collars to keep them afloat.

Another aid is a three-foot floating sprayer they call a doodlebug. It's jet-propelled and guided by swimmers under water into the heart of a blaze where it shoots torrents up into the timbers.



Different kind of bike: tiny wheels, rubber springs

British makers of the bicycle at left boast they've made the first basic design change in 70 years. It has 16-inch wheels, ultra-rigid frame of oval tubing, substantial luggage space, and an adjustable saddle that fits one size to an entire family.

Small wheels, which lower the center of gravity, and a long wheelbase give stability. Tires are inflated to a rock-hard 60 pounds to reduce resistance to roll, but rubber springs smooth the bumps. Moulton Bicycles, Ltd., Bradford-on-Avon, makes five road and racing versions.



Streams of water poured in from under dock penetrate complex of tar-soaked and creosoted timbers.

Trailer-truck feeler prepares big haul

To check highway width before transporting preassembled 40-ton RIFT (Reactor-In-Flight-Test) vehicles with nuclear engines, Lockheed sent ahead a truck and trailer equipped with a pipe framework. Rounded arms measured for the 35-foot diameter of the rocket stage; a 40-foot mast checked overhead clearance. The trial run helped prepare a special road map of the 435-mile route from Port Hueneme, Calif., to Jackass Flats, Nev. RIFT vehicles will be shipped next year for static tests by the National Aeronautics and Space Administration.



Like to live in a 60th-story apartment overlooking Lake Michigan, park your car 18 stories high, ride an elevator to your boat? Then move into—

MARINA CITY

By James M. Liston Illustrated by Ray Pioch

THIS most spectacular new building in America looks like two stacks of giant poker chips piled on the north bank of the Chicago River.

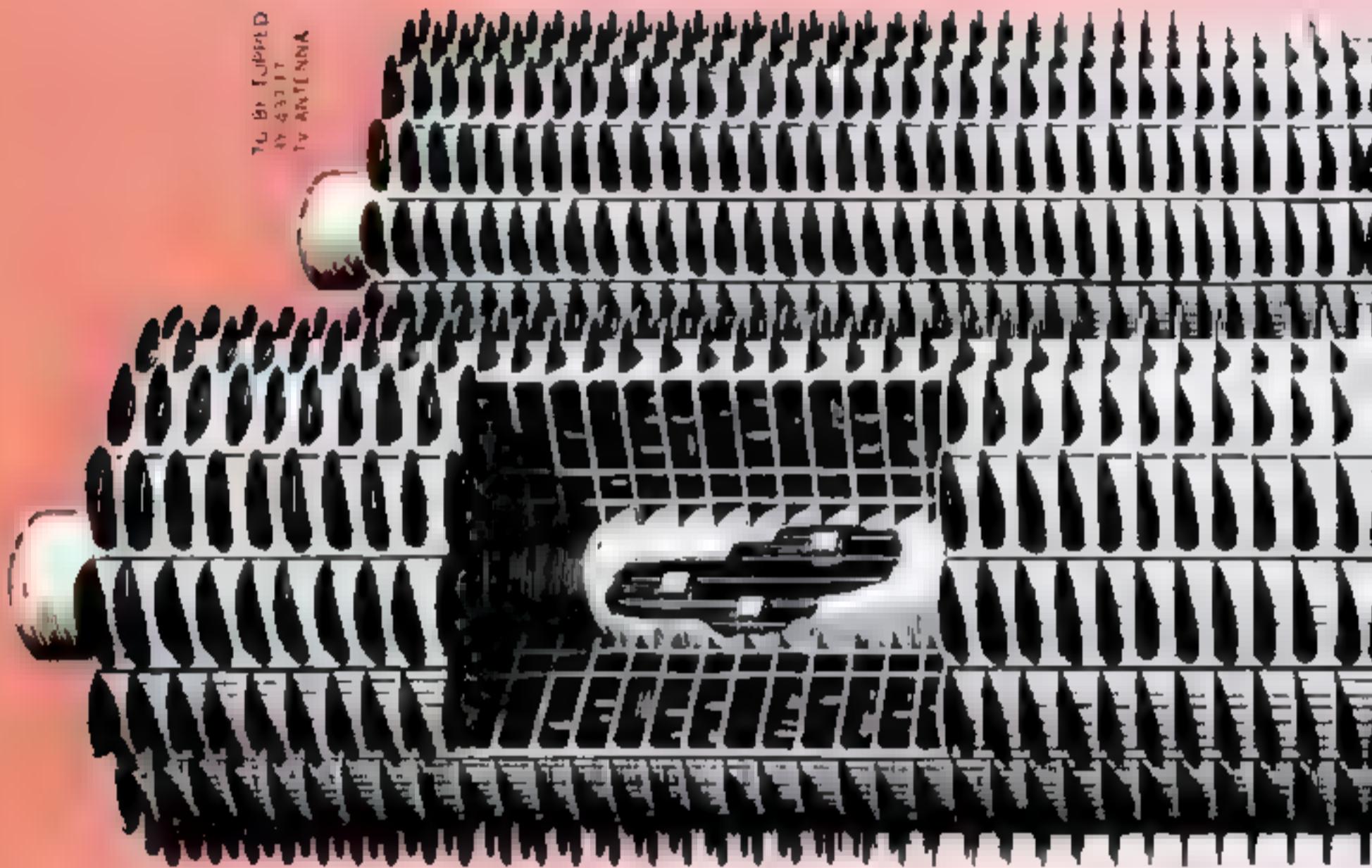
The two towers of Marina City represent a cool \$36 million bet that a big idea boldly executed will pay off. The big idea

- A downtown skyscraper apartment building so close to everything that a man can walk to work

- A five-building "city within a city" with an exciting atmosphere that gives prestige to the address. In the "basement," or first plaza level, a 700-seat marina (hence Marina City).

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LAWNDY AND STORAGE
CAR SERVING BELOW

LAUNDY AND
CAR SERVING BELOW

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The Post

Success hinged on getting materials and equipment up

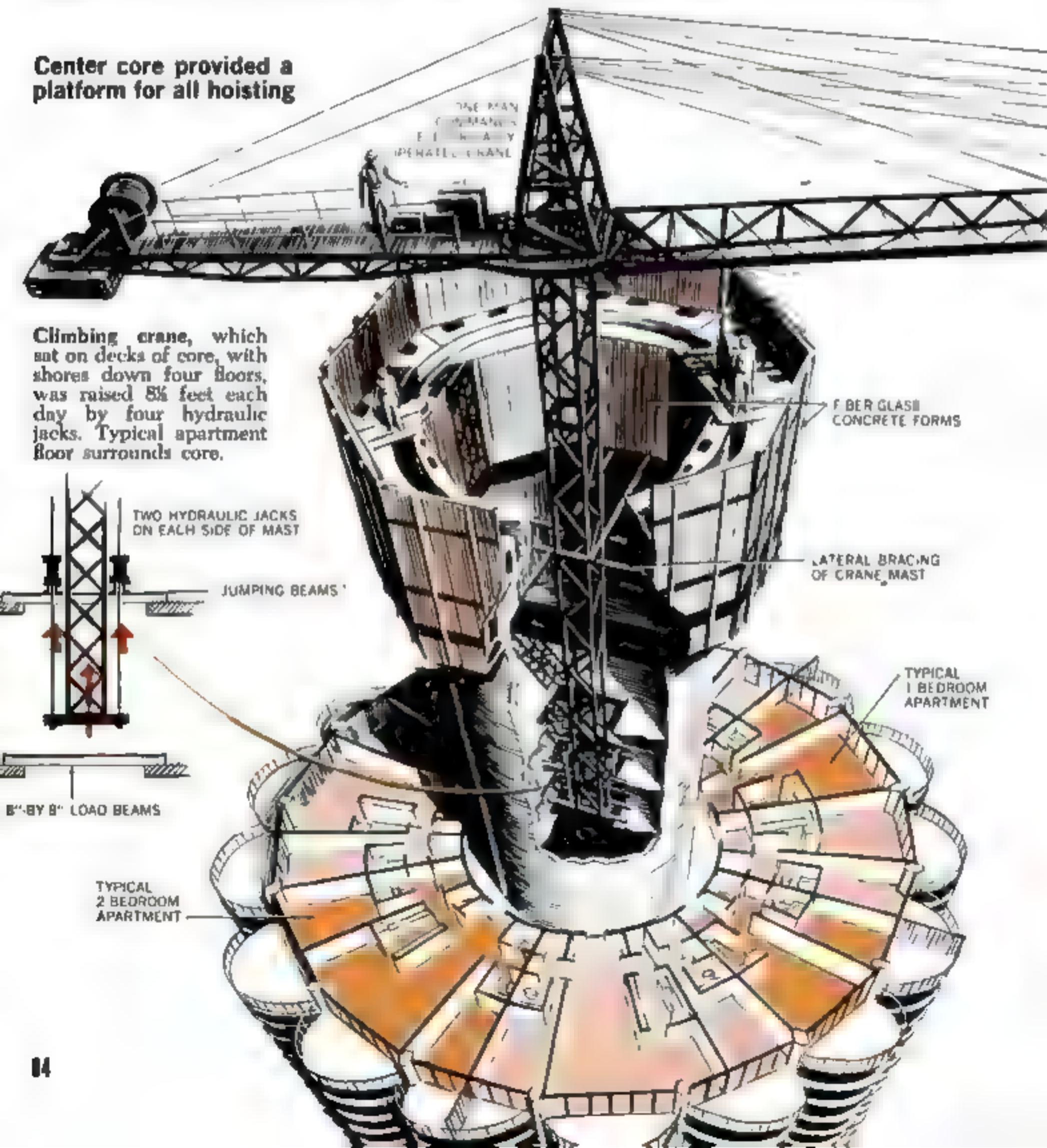
several acres of restaurant and shopping space, a gym, a swimming pool, and an exhibition hall. On the first 19 floors of each tower, spiraling parking ramps for 500 cars; on the 20th, storage and laundry facilities; and above the noise and dirt of the city, 40 floors of apartments. In the "back yard," a year-round skating rink, a 34-lane bowling alley, a 1,200-seat theater, and a 16-story office building on stilts for those who want to limit

their commuting to a 28-second elevator ride.

- A building that takes city dwellers out of boxes and offers them wedge-shaped rooms expanding toward the horizon, with cantilevered balconies to let them peer down right into the heart of Chicago.

The man who thought he could make it come off is architect Bertrand Goldberg. The investors who bet he could

Center core provided a platform for all hoisting

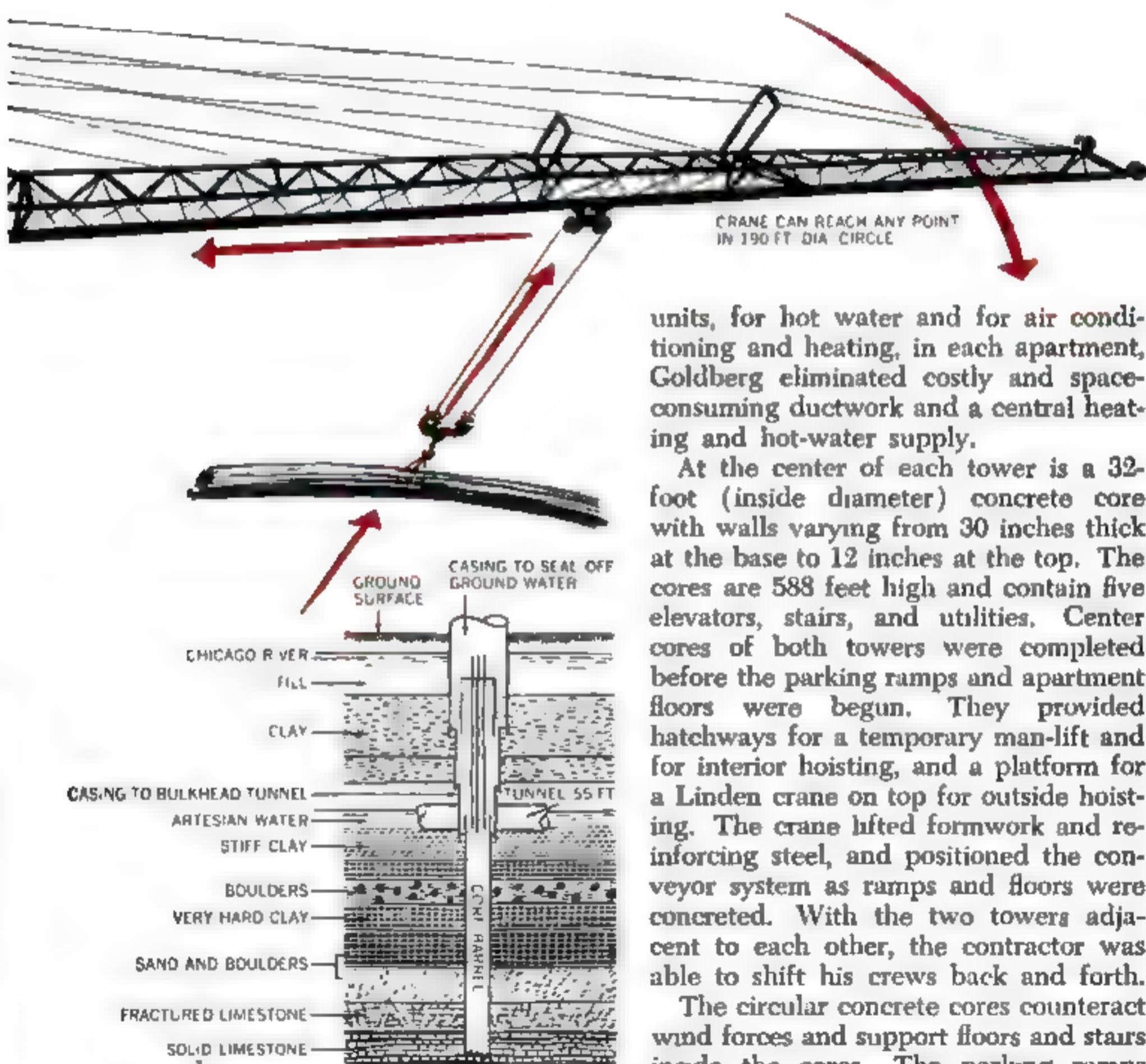


into the air as the job rose. Solution: the Linden crane

are the Building Service Employees International (the janitors' union), a string of banks, and the FHA. Wags call it "the house the janitors built." Few janitors can afford to live in it (rents range from \$115 for an efficiency apartment to \$350 for two bedrooms), but the project benefits the union funds.

Why round? Goldberg used a circular form for the high-rise towers of the five-building complex because: 1) It gave the

highest ratio of usable floor space to exterior skin. 2) It reduces actual wind loads and the wind stresses that the building code requires be taken into account. 3) The circular shape reduces the length of supply and return runs for utilities. Since all utilities—heat, air conditioning, cooking, and hot water—are serviced by electricity, only electricity, cold water, and telephone had to be supplied to each tenant. With individual



Steel-core barrel caissons (158 were installed) penetrated fill to limestone. Water-filled tunnel was sealed with steel-shell bulkhead.

units, for hot water and for air conditioning and heating, in each apartment, Goldberg eliminated costly and space-consuming ductwork and a central heating and hot-water supply.

At the center of each tower is a 32-foot (inside diameter) concrete core with walls varying from 30 inches thick at the base to 12 inches at the top. The cores are 588 feet high and contain five elevators, stairs, and utilities. Center cores of both towers were completed before the parking ramps and apartment floors were begun. They provided hatchways for a temporary man-lift and for interior hoisting, and a platform for a Linden crane on top for outside hoisting. The crane lifted formwork and reinforcing steel, and positioned the conveyor system as ramps and floors were concreted. With the two towers adjacent to each other, the contractor was able to shift his crews back and forth.

The circular concrete cores counteract wind forces and support floors and stairs inside the cores. The parking ramps and apartment floors are supported by

[Continued on page 194]

Flying the Atlantic Without a Navigator



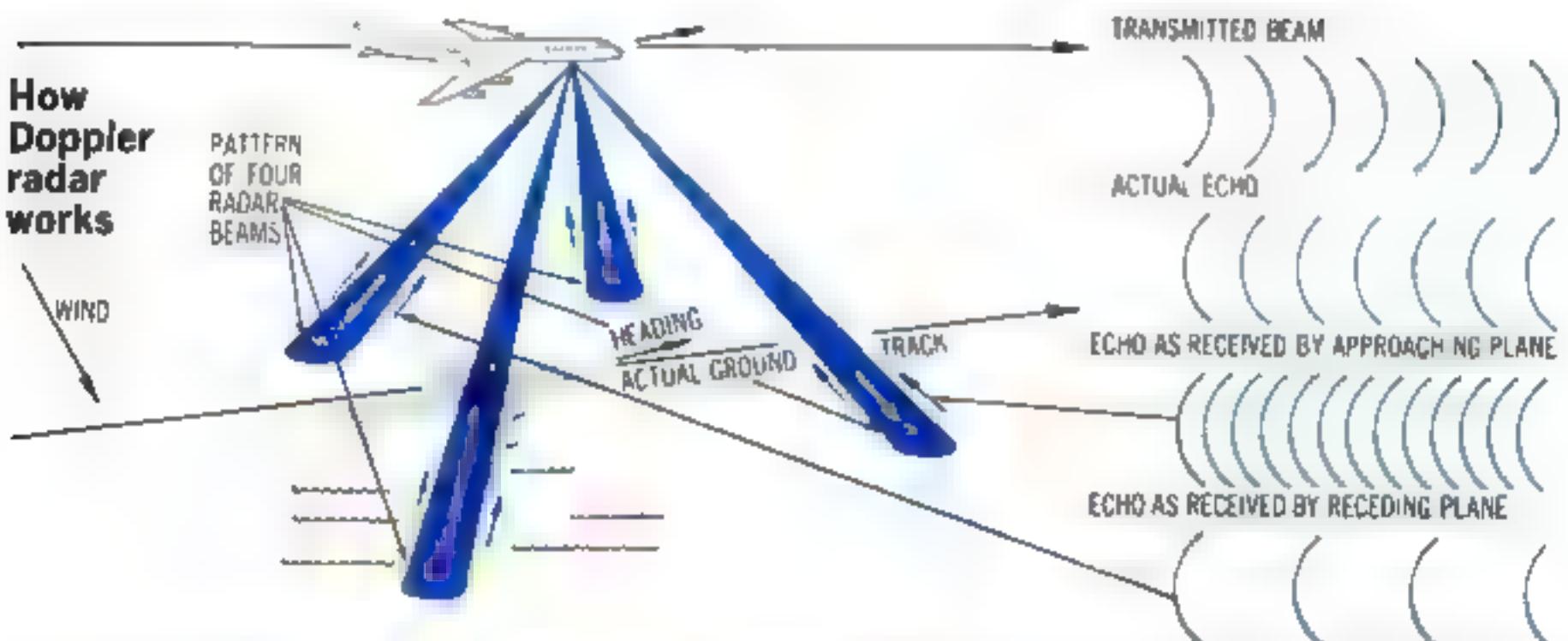
Ocean vessels, navigating by stars and sun, still use time-honored sextant—as on the S.S. United States, above.



Transocean planes have used this aerial version of sextant to get star "fix"—but task is too slow for jets.

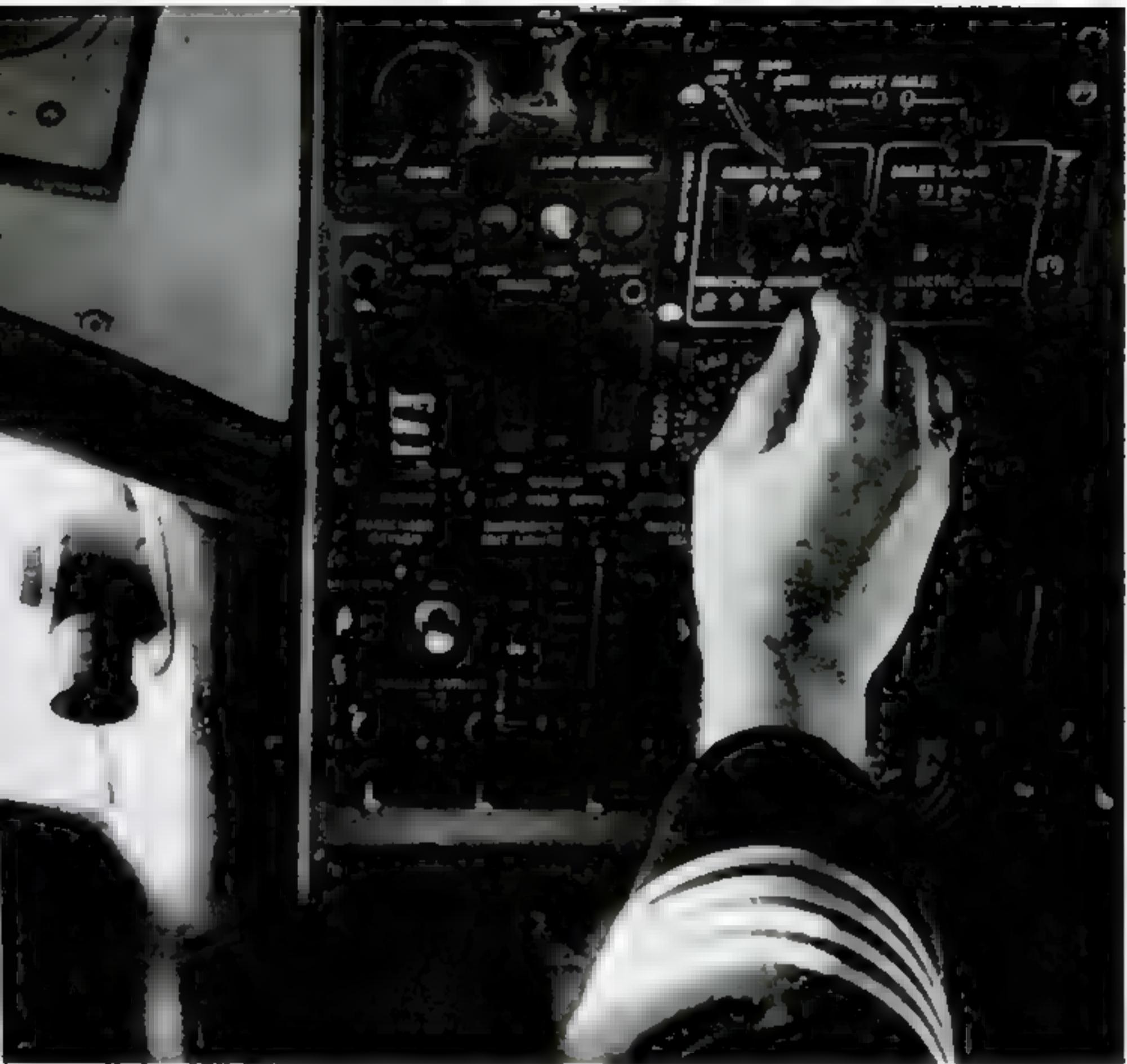


New Doppler system, dispensing with navigator and celestial observations, is TWA's answer to guiding fast jets. The pilot (right) simply dials intended course into overhead panel. Radar beams detect straying, and guide him back to course.



Four radar beams are aimed seaward by antenna. Echoes tell jet's speed in each beam's direction, by "Doppler effect" shown at right.

Jet's motion alters echoes' apparent frequency.



High-speed jets have forced a break with classical navigation by stars and sun, in favor of radical new Doppler system

By Robert E. Smallman

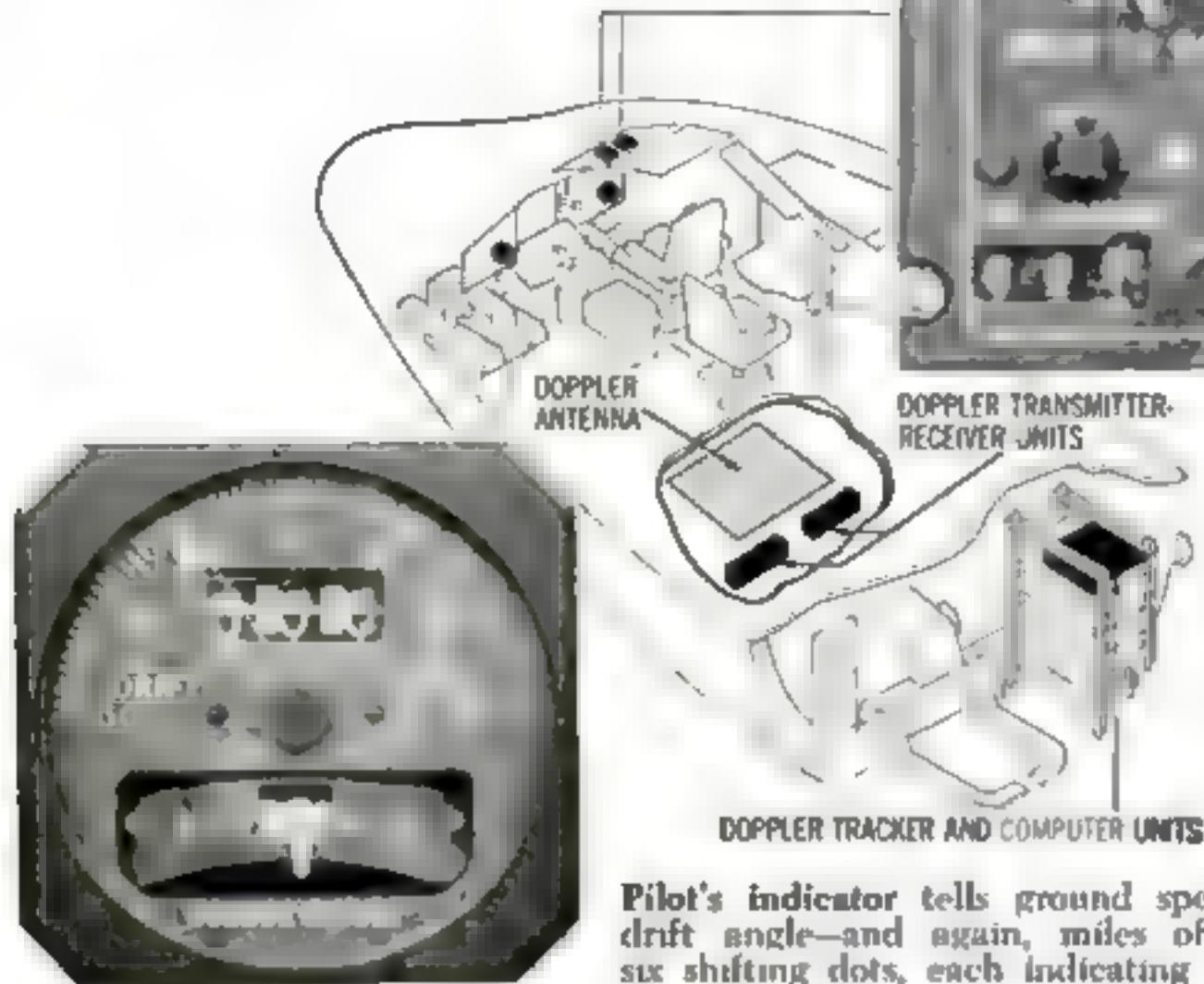
THREE'S an empty seat up front these days on TWA's overseas jet flights. Although his swivel chair remains bolted to the flight deck, the navigator is as extinct as the dodo bird.

An electronic system called Dual Doppler Radar has taken over his job. Constantly it fingers the sea beneath the speeding plane with four diverging radar beams. Apparent changes in frequency

of the beams' echoes, due to the plane's motion in any direction, show its ground speed and track. If the plane is straying from its intended course, as unpredictable winds may make it do, a computer comes up with the direction and distance to fly to get back on course.

Thus, it's estimated, a pilot can keep a jet within an average of 10 miles to left or right of a planned course. That compares with a margin of safety of 60 miles, to each side of an aircraft, that

Pilot uses these knobs and indicators—and Doppler system does the rest



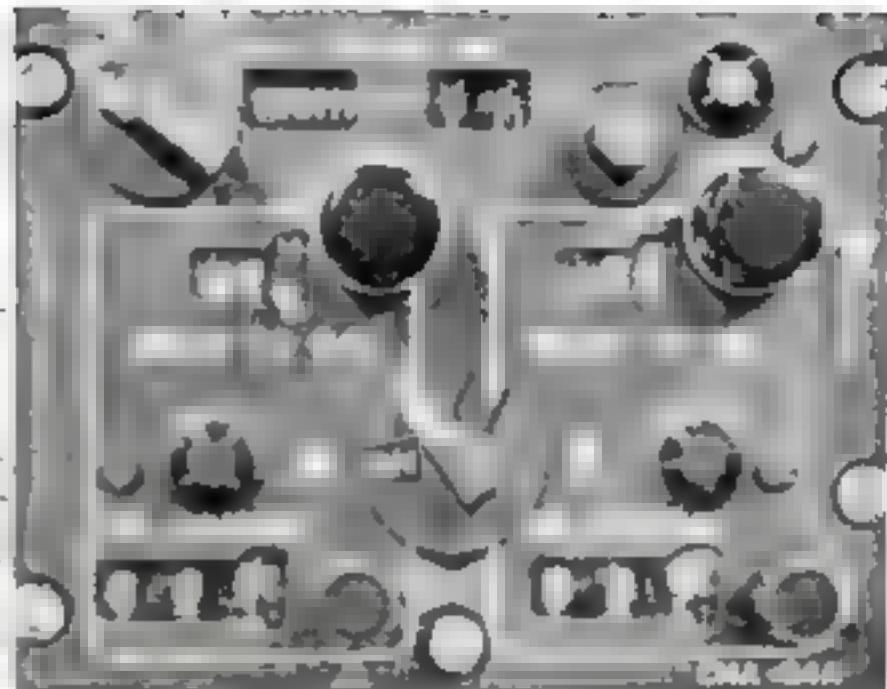
Pilot's indicator tells ground speed in knots, drift angle—and again, miles off course, by six shifting dots, each indicating two miles.

present Atlantic "air corridors" provide.

Jet liners flying the ocean nearly as fast as sound, at altitudes where winds normally range from 100 to 200 knots, have forced a break with the traditional procedure of navigating by the stars and sun. A three-star "fix" to find a plane's position takes 20 minutes to plot. By that time a jet has sped 200 miles further. And it isn't good enough to know where you were, 200 miles back—conditions aloft change too fast.

For the safety of the 2,000,000 passengers who fly the North Atlantic in about 40,000 planes of all lines yearly, pilots need to know where they are right now. And that's what the new Bendix-developed Doppler system, which TWA has brought to an operational version with the approval and cooperation of the Federal Aviation Agency, tells the pilots of its jets.

To see how simple the system is to operate, let's join TWA's Chief Pilot C. W. Horstman on a typical Atlantic cross-



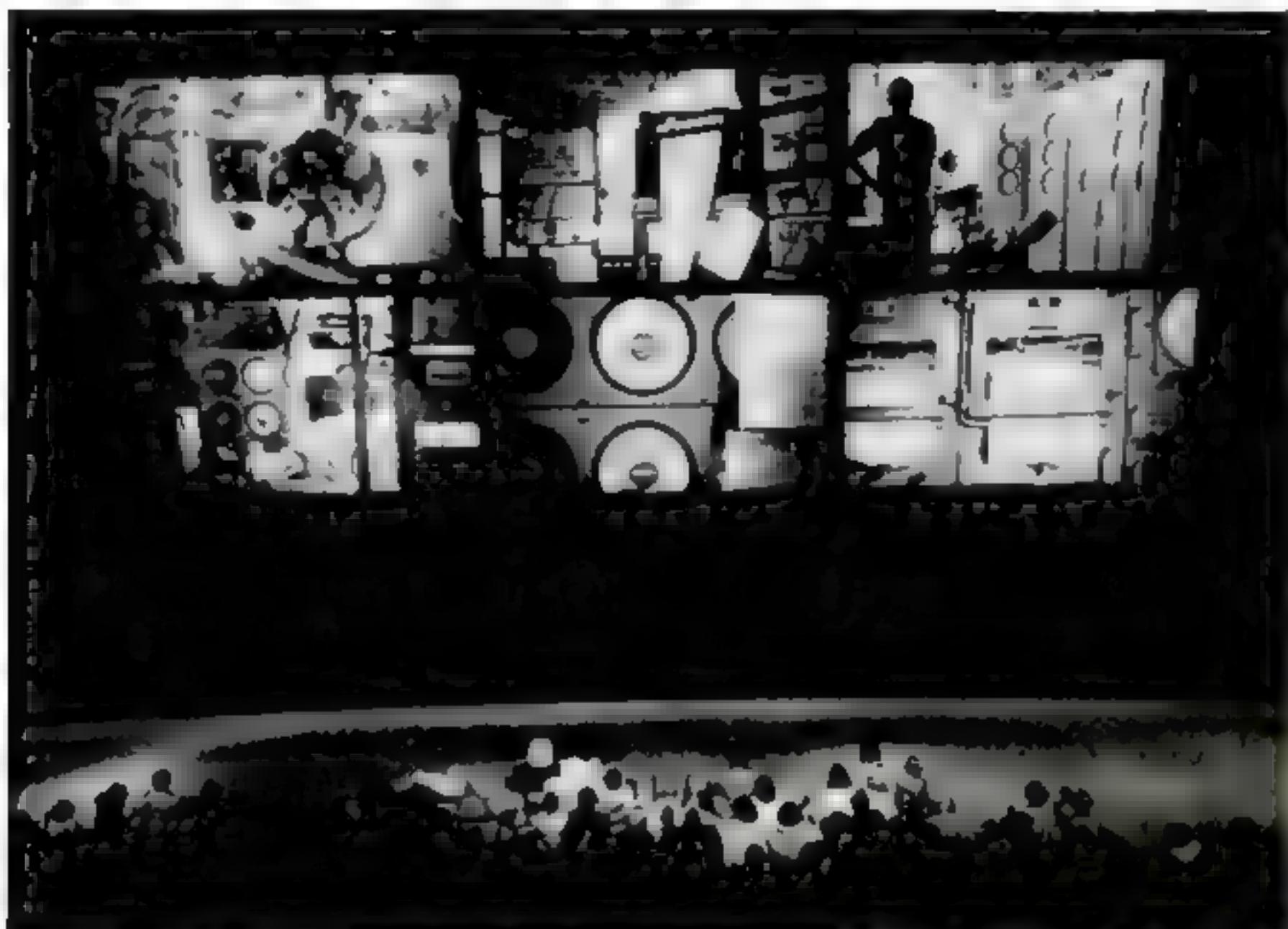
Computer controller is fed by pilot with selected course and distance for two legs of flight. Numbers tell miles left to go, and miles off course to left or right ("Offset Miles"). Center drawing shows location of pictured instruments.

ing. In Flight Operations, he plots a great-circle course, dividing the 2,600-mile flight into seven legs; they average 375 miles in length, each following a slightly different compass heading. After personally checking the big 707's exterior, he goes aboard and, with his co-pilot, runs a minute cockpit check. Behind him in the radio compartment are 80 pounds of electronic equipment—the Doppler's radar transmitter and receiver and its computer.

Just before takeoff he programs flight information into the Doppler. Side by side on the ceiling instrument panel are computer controllers marked "A" and "B." Into the "A" side he dials his first heading and the distance of his first leg. These appear as numbers in little windows marked "Selected Course" and "Miles to Go." Into the "B" side goes the same information for the second leg.

After takeoff, Horstman circles, and flies over a radio-marker beacon—his

[Continued on page 213]



Synchronous projectors show only film of its kind. It tells of growth and unity of science.

Permanent science exhibit follows record fair run

So popular did the U.S. Science Exhibit prove last summer at Seattle's World's Fair that it is reopening this spring on a full-time basis. The \$10,000,000 center attracted more than 6,500,000 persons in the six months the fair was open. Turned over to the Pacific Science Center, it was kept open on weekends during the winter, with three new exhibits added in December: a planetarium, optical light maser, and satellite-tracking display. Admission is \$1 for adults, 50 cents for students.



Plug-in vest heats from dashboard

Riders in open cars, boats, tractors, or on motorcycles can now keep warm on cold days, says the inventor of this plug-in vest. It has flexible heating elements enclosed in plastic front and back panels, plugs into a cigarette-lighter receptacle connected to a 6-, 12-, or 24-volt battery.

Normally worn inside the jacket, the French device is demonstrated here by a Delaney Electronics, Ltd., employee on a cold day in London. When not in use, the plug can be tucked in a pocket.



Pigeons match intricate patterns learned in method that led to building teaching machines.

THE '63 CARS:

How They're Better in

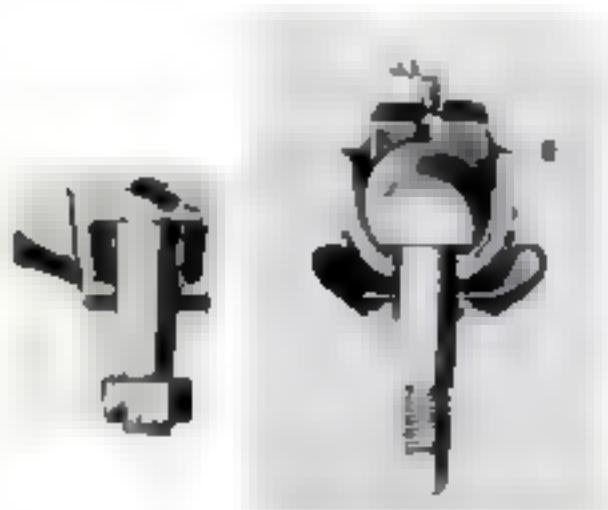
EVERY autumn U.S. automobile manufacturers take the wraps off their spanking-new products in thousands of showrooms from Bangor to San Diego. They advertise the big

changes—new engines, new transmissions, new body shells.

But there are hundreds of other changes built into the new cars for performance, convenience, or looks that the



• Chevy has a fresh answer to rocker-panel rusting (above). Rain water flows from inlets in front of the windshield down through the panels to wash out dirt. Drying air follows the same course. Windshield pillars are straighter.



• Ever hear of polytetrafluoroethylene? Well, that's a fluorocarbon resin that is being used in the upper-control-arm spherical joint of Chevy's front suspension (above, right). This low-friction material is one reason for Chevy's extended-lube periods. The pitman-arm ball joint (left) is designed to be maintenance-free.

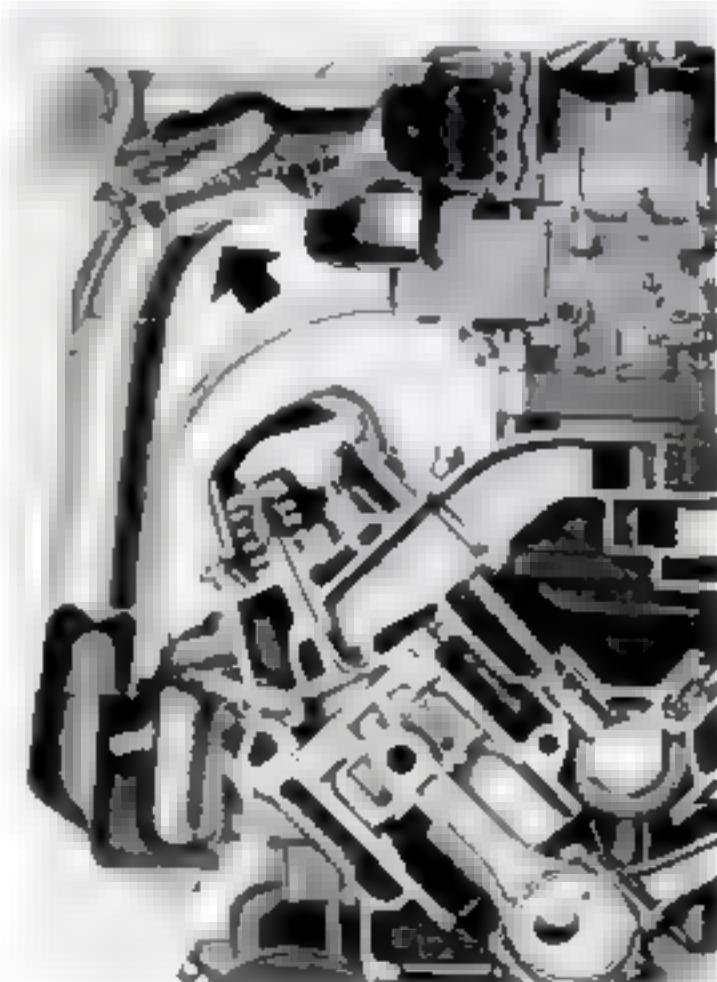
• Rambler's Ambassador sports a double universal joint in the drive shaft for "constant velocity" as it turns. Most joints set up a vibration. Rambler's is smooth as silk.

• You can't trip over seat belt anchorages when you climb into Cadillac's rear seat—they're now in the floorpan side walls.

• To save weight, Oldsmobile Rocket, Skyrocket, and Starfire engines use an aluminum front cover and water-pump housing.

• Ford now has rubber window seals. One immediate result is less internal rust from dripping.

• A "heat stove" (below, arrow) on Ford Motor's 260-inch engine, powering the Fairlane, Falcon, and Meteor, hastens cold-weather warm-ups and prevents carburetor icing. Heat comes from the exhaust manifold. A thermostatic valve shuts it off.



• Parallel-action windshield wipers on Rambler's Classic and Ambassador sweep two-thirds of the glass area.

• Studebaker has direct-reading oil and amp gauges on all models. Studey, too, has parallel-sweep wipers, plus a fail-safe split brake system like Cadillac and Rambler.

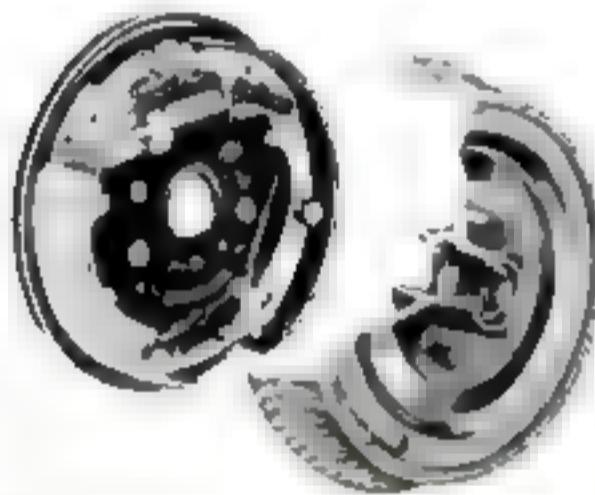
36 Little Ways

By Devon Francis

motor makers seldom emphasize. The 1963 cars are from an especially fine vintage year for innumerable little refinements. On these pages you will find some of the "tremendous trifles" that

improve the current cars—most of them hidden from view behind the sheet metal. They range from devices to keep convertible tops from flapping to heat stoves for faster warmups in cold weather.

- A can-type, throwaway fuel filter has been adopted by Buick for its V-8s with four-barrel carbs. It does a better job, lasts twice as long. It's more easily removed and replaced, too.



- Three hard-chrome buttons keep Ford brake shoes (above) from sticking to the backing plate when released.

- Both Pontiac and Chevrolet have solved the problem of side-flap and "ballooning" in their convertible tops—a bother on all "rug-roof" cars. The fabric is snugged down with adjustable steel retaining cables.

- An airfoil (winglike) shape in Chrysler Corp. wiper-blade brackets keeps the blades from separating from the glass at high speeds.

- Also from Chrysler: anti-corrosion, aluminized mufflers.

- Lincoln Continental sedans have aluminum brake drums in front for slower fade.

- Distributors on Mercury engines require less adjustment—breaker points are of pure tungsten, silver-brazed.

- Buick air conditioners and heaters are in one housing, with a consequent weight reduction. And the entire unit is mounted in the center of the instrument panel, for easier operation and servicing.

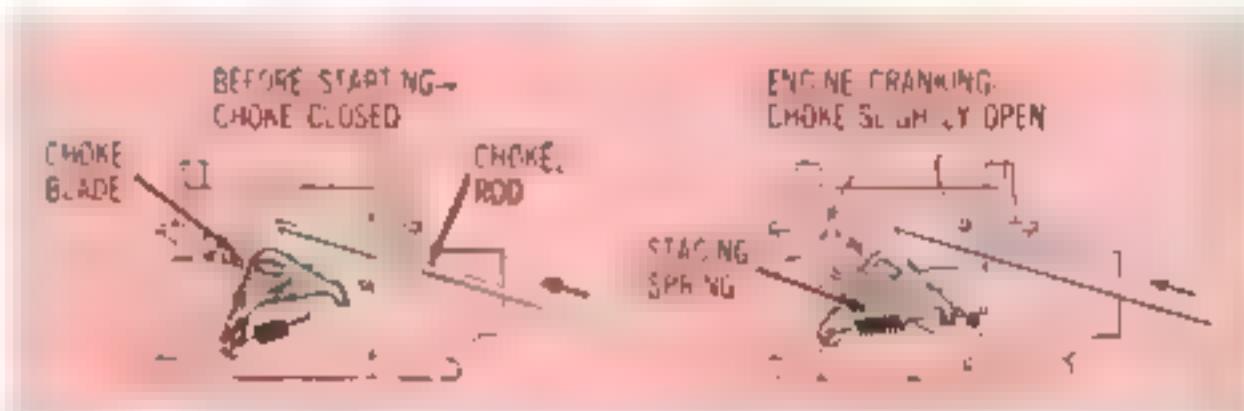
- A "nesting" exhaust pipe—it is enclosed in another pipe—reduces noise from resonance in the Thunderbird.

- A check valve in the oil-filter drain-back line on Dodge Darts reduces oil-pressure build-up time in starting the engine.



- A parking lever is added to the Chrysler's pushbutton control console (above). It's actually a rod that locks the output shaft to its housing, similar to the "Park" position on other cars with torque-converter transmissions.

- Supercharged Studebaker engines have a viscous fan drive to save power. It slows the fan at high engine speeds.



- A coil spring and bell crank in the carburetor choke mechanism (above) of the Plymouth Valiant reduces choke-blade closing torque when firing up at temperatures below zero. This meters a proper starting mixture, gives a faster ignition "catch," helps prevent flooding by heavy-footed drivers.



- A thiefproof storage compartment (above) is concealed beneath the cargo floor of Rambler Classic and Ambassador station wagons. The glove-box key locks it.
- The Mercury Comet hood is counterbalanced with coil springs to take the toil out of lifting it.
- Standard on all deluxe models and optional on other Olds F-85s is a full safety-padded instrument panel made of thicker material.

- Like other Chrysler Corp. cars, the big Dodge abounds with molding-attachment clips made of nylon. This eliminates the electrolytic corrosion that metal clips cause.

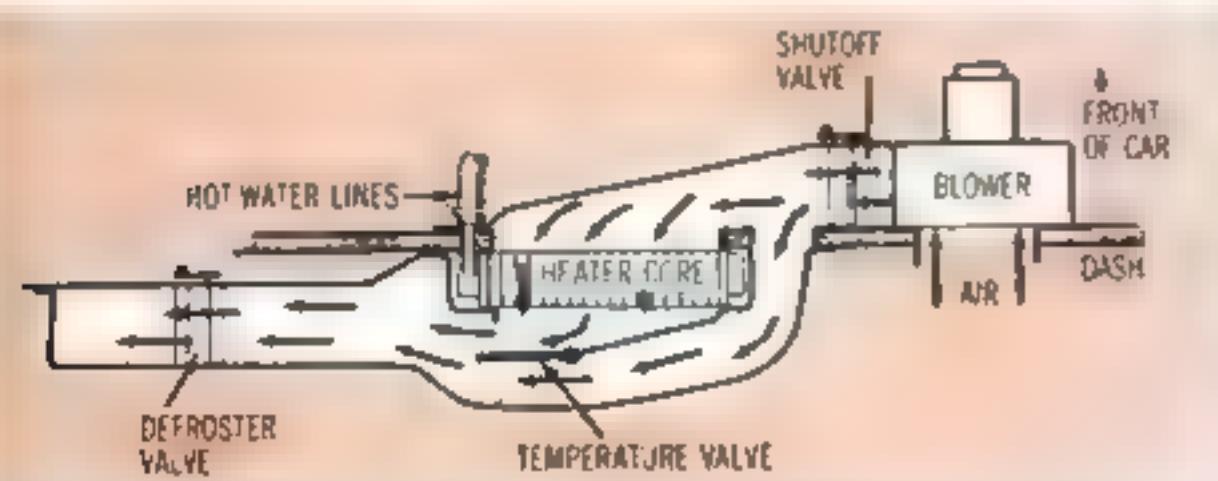
Caddy's optional Cruise Control (which maintains any selected speed) has an on-off switch. This allows the system to be used as a speed indicator, through back pressure on the accelerator, even when not locked in.

- The Tempest's rear suspension (below) has a new lower control arm to improve handling. "Low-rate" rubber mountings cut road noise.



- The Plymouth's bumper sections are beefed up to provide better collision protection, and height is adjusted for better alignment with bumpers on other cars.

- The constant jounce of a car's springs and shocks strains exhaust-pipe joints. Ford has solved this with a self-aligning joint to insure a seal against gas seepage.



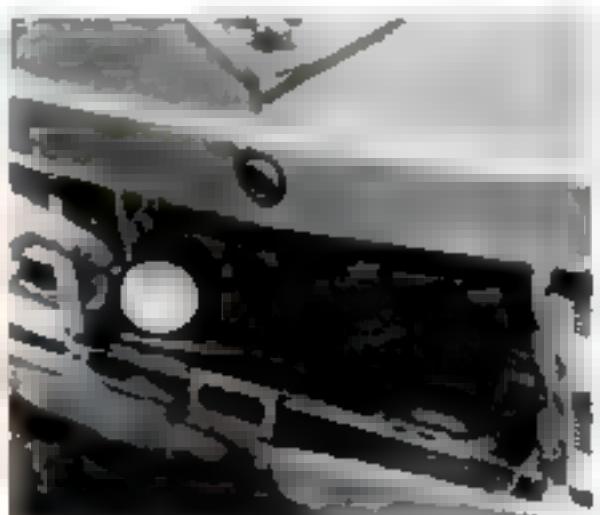
- Buick's heater is less sensitive to speed. Formerly, the temperature of the air from the heater was controlled by a valve that regulated the amount of water through the core. The new heater mixes hot and cold air. Part of the incoming air bypasses the core, to be mixed later.



- All Olds engines have an oil-filler cap (above)—a washable and replaceable polyurethane element—that does a better job. In normal use, the element need be cleaned only each 12,000 miles.

- And again Plymouth: A stronger return spring on the throttle control gives a crisper accelerator feel. On cars with automatic transmissions, splash shields keep snow, slush, and water from collecting in the control linkage.
- Electric single-speed windshield wipers are standard on all Ford Falcons. Two-speed electrics are optional.

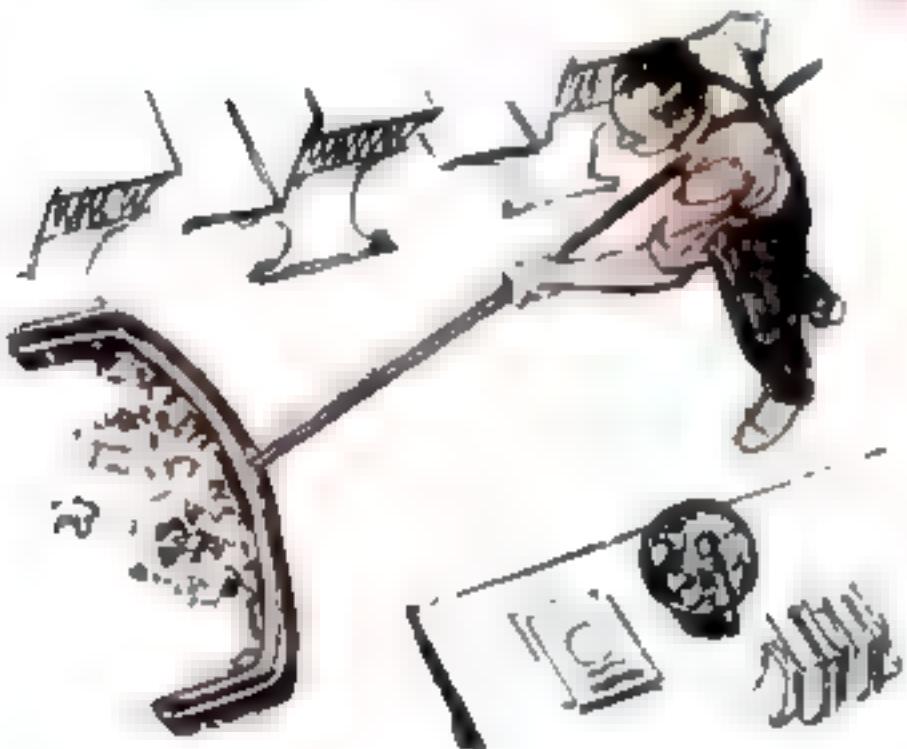
- The Chrysler New Yorker Salon has reading lamps for rear-seat passengers.



- The Cadillac's gas-tank cap (above), when placed in indentations made for it, becomes a brace to hold the little spring-hinged metal door open. Silly? No. Such doors, pushing against the gas nozzle, often get scuffed.

"I'd like to see them make..."

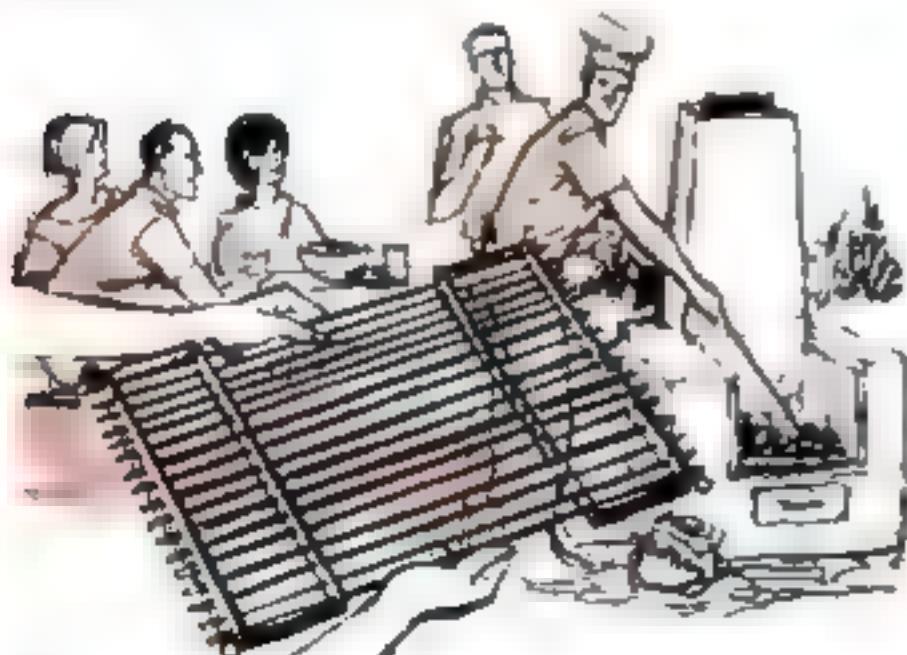
Headlight + dimmer switches on the gearshift levers of trucks. They'd make it easier to lower lights on hills and curves where there's lots of shifting.—*Clifford R. Kreiling, Palmdale, Calif.*



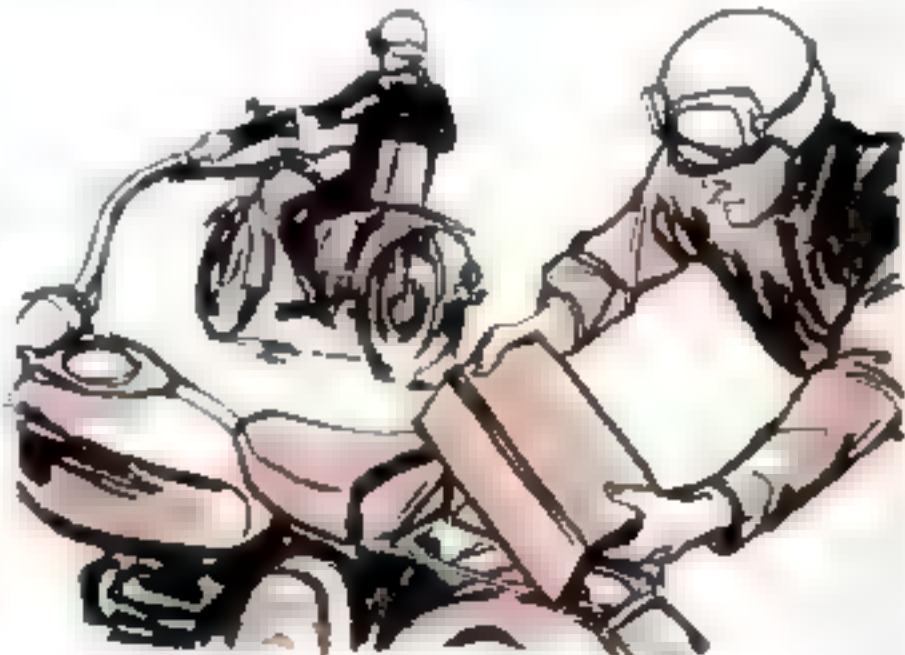
A curved push-broom for sweeping large areas, as in schools or factories. Flared ends would keep sweepings from escaping and save overlapping.—*Ernest Levy, New Orleans.*



Transparent aerosol cans for products used daily—shaving cream, toothpaste, insect spray—so you could tell when they're about empty.—*Mrs. R. J. Carpenter, Glenshaw, Pa.*



Come-apart barbecue grilles with fewer cross-pieces. The rods would lock at the ends for use, but could be slipped out for easy (and thorough) washing.—*J. D. West, Newark, N.J.*



A padded motorcycle backrest, curved to fit the back. To provide a flat seat for a second rider, you'd move it back and swing the curved side down.—*B. D. Calligher, Hendrick, Okla.*

Everyone has his own pet idea of a gadget that he would like to see in general use. What's yours? We will pay \$5 for each one published. Please use Government postcards.

only. Send to ILTC Editor, Popular Science, 355 Lexington Ave., NYC 17. Write your name and address clearly. Contributions cannot be acknowledged or returned.

Lightweight Liner...

She carries more passengers than the

ONLY 820 feet long, the *Canberra* is not the biggest luxury liner afloat. Yet the new British ship holds more passengers than any other ocean-going vessel.

She's one of the most revolutionary passenger ships of our time. Her entire superstructure, including masts and funnels, is aluminum. This makes her so light that she displaces only 45,000 tons and gains an extra deck—she has 15 in all. The *Canberra* accommodates 2,338 passengers. The *Queen Elizabeth* carries 2,314.

Last August the Canberra made her first Atlantic crossing, from Southampton to New York, in less than five days. Old stuff? Yes. The Queen Mary, Queen Elizabeth, United States, and France do it regularly.

in less time. But they all require four propellers to maintain such speed. The Canberra uses only two. Her twin turbo-electric engines, totaling 85,000 hp., push her along at 27½ knots.

She makes good time in harbor, too. A bow propeller driven by an 800-hp., 10-ton-thrust electric motor turns her quickly to either side. It saves up to an hour in docking, especially in small Oriental ports, where there may be as few as two tugs. The *Canberra* was built primarily for the Pacific trade.

At the pier, baggage and cars are speedily loaded. An elevator rolls out on a track on either side to hoist the cargo. Conveyor belts whisk trunks and suitcases—there may



Engines are aft, as in oil tankers and Great Lakes ore carriers. This leaves most of forward space for passengers, reduces engine noise and vibration. Plastic trim inside the ship virtually eliminates paintwork.

On first visit to New York, Canberra received a rousing welcome. The ship stands unusually high in the water, but her streamlined shape cuts wind resistance as twin props spin.

Queen Elizabeth

be as many as 9,000—to the proper decks, where they're pushed off automatically.

Passengers aren't annoyed by engine vibration. The two 30-ton propellers, 20 feet, 6 inches across, run in "broken step."

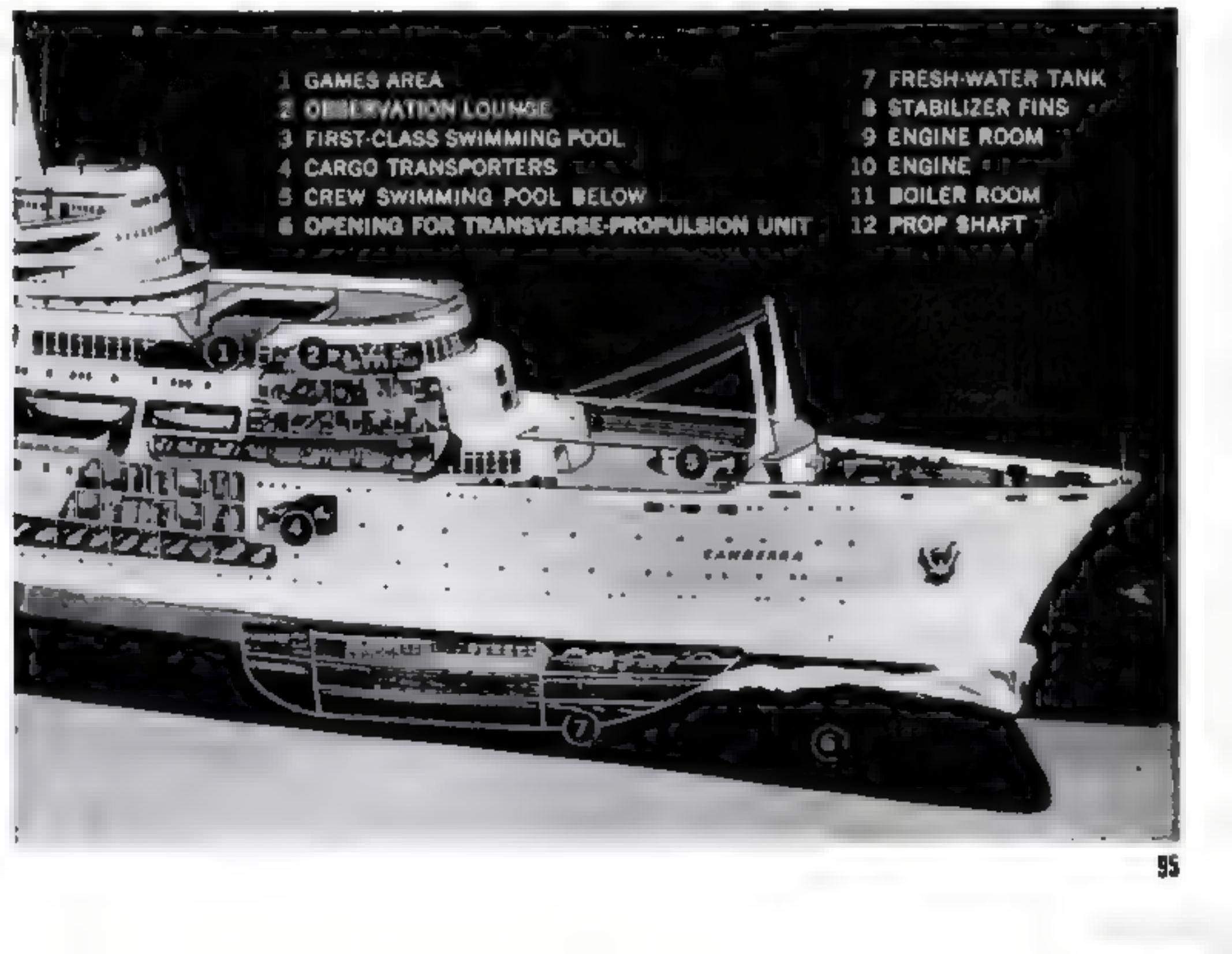
The two stacks are side by side near the stern to keep smoke away from decks and cabins. The top deck, where passengers play games or lounge in deck chairs, is completely screened from the wind.

Pitching and rolling—and subsequent seasickness—are practically eliminated. The ship has a bulbous bow similar to those on some World War II battleships and carriers. It rounds out like a globe below the waterline. In ordinary seas it greatly reduces pitching. But should the weather become

bad enough to lift the bow out of the water (it's happened in a Pacific monsoon), the captain admits it's worse than a knife-edge bow. That big, round surface must be forced back into the water.

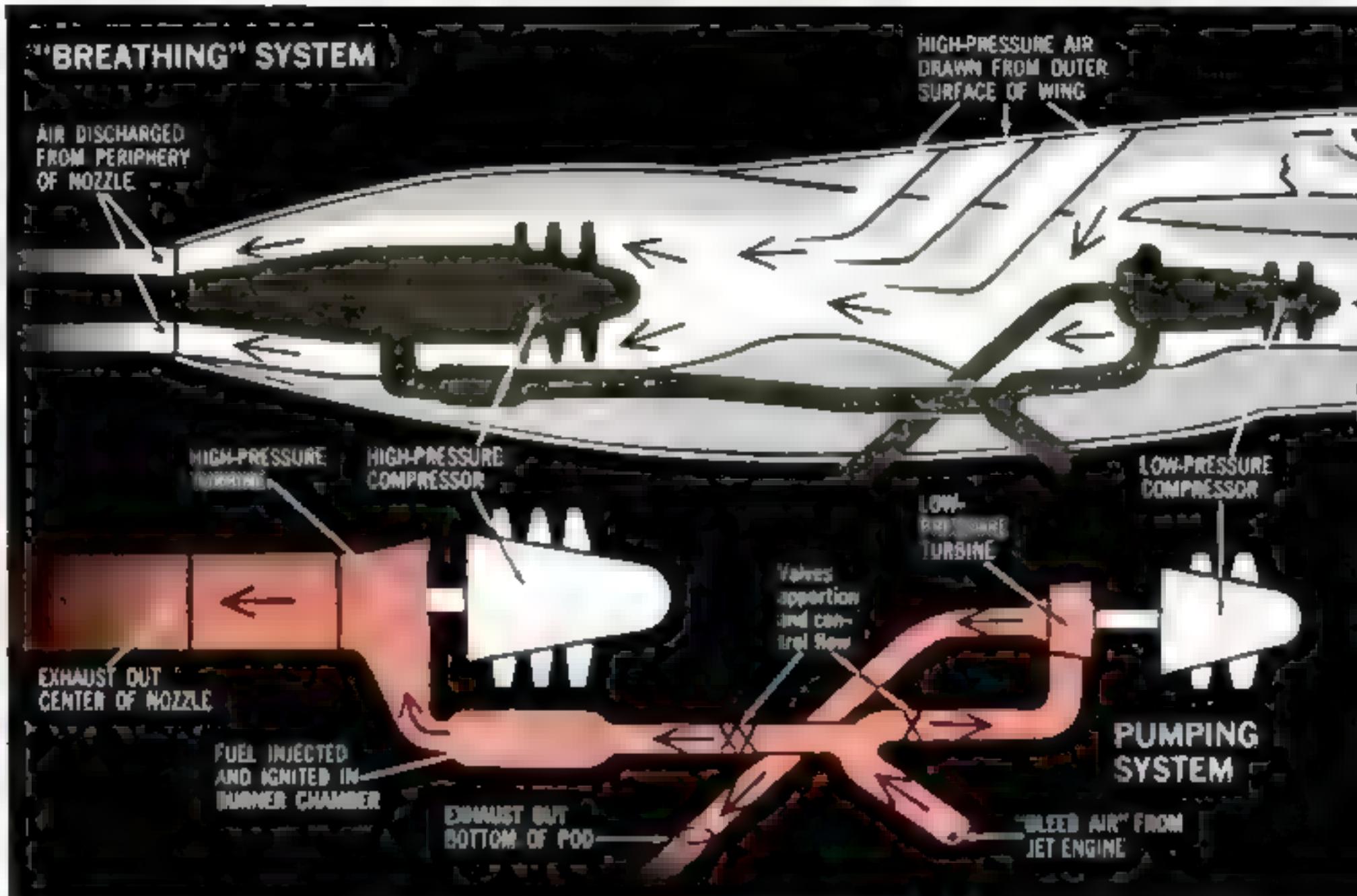
To cope with side-to-side motion—rolling—two pairs of gyroscopic stabilizers, resembling stubby airplane wings, are extended below the waterline. In rough seas they reduce roll to as little as 1½ degrees—which is barely noticeable. Recently, during a full Atlantic gale with a heavy following sea, passengers enjoyed a fancy-dress ball.

But luxury doesn't come cheap. The ship cost \$1,000 a ton—a tidy \$45 million in all.—*Gardner Soule*.



- 1 GAMES AREA
- 2 OBSERVATION LOUNGE
- 3 FIRST-CLASS SWIMMING POOL
- 4 CARGO TRANSPORTERS
- 5 CREW SWIMMING POOL BELOW
- 6 OPENING FOR TRANSVERSE-PROPULSION UNIT

- 7 FRESH-WATER TANK
- 8 STABILIZER FINS
- 9 ENGINE ROOM
- 10 ENGINE
- 11 BOILER ROOM
- 12 PROP SHAFT



Plane's Wing 'Breathes' to Boost

By Wesley S. Griswold

A PLANE with wings that breathe, made over by Northrop from an Air Force WB-66 bomber and renamed the X-21, may soon make aviation history.

In demonstration flights out of Edwards Air Force Base, it's expected to prove that the braking drag of air friction on a plane can be virtually eliminated—simply by sucking in air from the wing surface and expelling it aft.

Further, the experimental X-21 and a coming sister craft are intended to show that its breathing-wing system is feasible for an operational airplane. The resulting boost in range, payload, or endurance, Northrop says, would be dramatic.

Take a transcontinental jet airliner that now flies 3,700 miles on 25,000 gallons of kerosene. With wings like the

X-21's, and the same amount of fuel, it could fly 6,000 miles. Alternatively, it could carry 15,000 pounds of extra payload to its present range. Or it could stay in the air—for military surveillance, say—hours longer.

The secret lies in getting rid of turbulence in the "boundary layer," the air nearest the skin of a plane in flight.

One way is to pump air outward through holes in the wing—literally blowing away the "burbling" layer. Since this gives control surfaces a better grasp on the air, it's now being developed for landings and takeoffs in limited space. Another way to remove the turbulent layer is just the reverse—to suck air *into* the wing. This, the X-21's method, is preferred for reducing drag in flight.

Fine slots run along the outside of the X-21's big new wings, at top, bottom, and leading edge. They form air intakes.



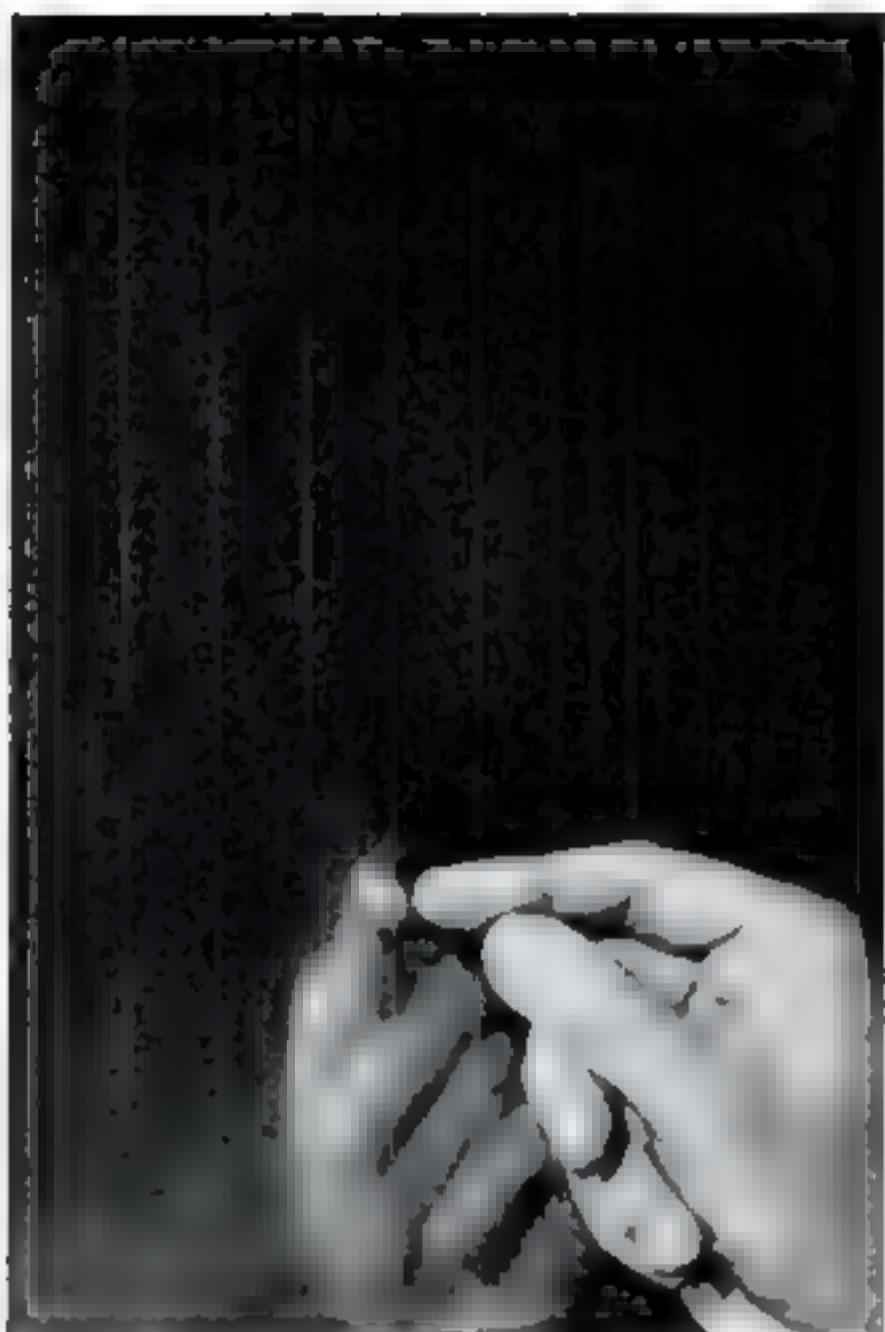
"Breathing wing" sucks in air, and pumping pod expels it rearward, as shown in cutaway drawing of wing and pod. Smaller views show air-pumping mechanism in pod, and location of pods on experimental X-21 planes flown to test the system.

Its Range

Inside a wing, the inhaled air passes through ducts to a pumping pod slung below each wing at mid-span.

Two compressors in the pod provide the suction. A low-pressure compressor draws air from the forward, upper wing surface. A high-pressure compressor sucks air from the remainder and discharges all the inhaled air rearward.

To drive each pod's compressors, a stainless-steel pipe brings "bleed air" from the nearer of the plane's two aft-mounted jet engines. This is air that has been compressed and heated in the engine, but diverted before reaching the engine's combustion chamber. At the pod, part of this pressurized-air stream whisks the low-pressure compressor. The rest goes to a burner chamber where fuel is squirted into it, and ignited by a spark plug. Given this added kick, it spins the high-pressure compressor.



Outside of breathing wing is pin-striped by these tiny slots through which air is drawn from surface to interior. Slots, nearly parallel, are spaced from a half-inch to three inches apart.



Inside a wing, tributary ducts—whose yellow-green plastic sections resemble a parade of caterpillars—lead the air from wing slots toward bigger ducts and air-pumping compressors.



V shape stabilizes instrument-carrying balloon

Joined like two blimps cheek-to-cheek, this tethered airship will keep GE scientific instruments aloft for long periods in almost any weather. The V shape, designed by Goodyear, enables the craft to ride at stable,

nose-high angles. Each ship is 110 feet long and 27 feet in diameter. Automatic devices maintain the pressure of the helium inside the gas bags at varying altitudes and temperatures.



Reds ride on air cushions, too

The Soviet hovercraft Neva is shown here during a trial run at Leningrad along the river for which it was named. The 38-passenger air boat is said to have a maximum speed of 40 m.p.h., riding on a cushion of air created by fans driven by two aircraft

engines and trapped between rounded hull ends and boats on the sides. Forward speed is obtained from a third engine, mounted at the stern and powering a propeller. Neva's relatively simple plenum arrangement is probably less efficient than similar machines developed in the U.S. and England, say experts on ground-effect machines.

Metal Detectors

...can they really spot buried treasure?

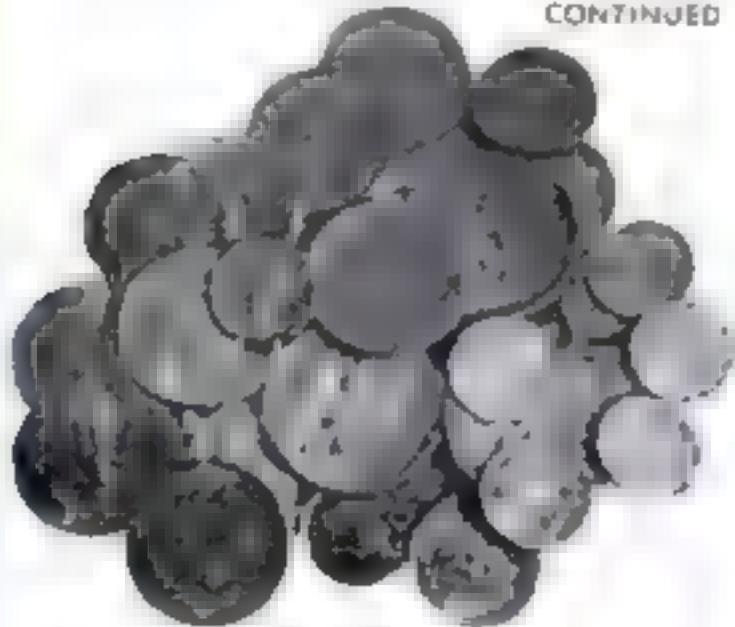
By V. Lee Oertle

IT'S both wild-goose chase and fine art—will-o'-the-wisp and golden promise. But there's just enough truth in those lost-treasure stories you've heard to make metal detectors the hottest hobby in years.

I dogged the tracks of experts, tested nearly all the major brands, unearthed heaps of tin cans and a tantalizing handful of relics, and I'm convinced. The new breed of metal detector is exciting.

Advertising claims often sound too good to be true. Typical example: "Retired man finds for-

CONTINUED



Face value of old coins often is dwarfed by prices collectors are willing to pay. This is part of a huge cache unearthed in a New Mexico ruin.

You work each area in a pattern, covering every inch. Most of your finds will be junk, but there's always the chance the next will be a bonanza





Abandoned mines are happy hunting grounds for relics, coins, and other valuable items. So are deserted buildings, seashores, old battlefields, and other historic spots.

tune hidden in back yard." What really happened was that an eccentric man buried his life's savings in a tin can—and forgot where. Police used a metal detector to find the container.

Another example: "Explorer reaps thousands in old Spanish gold coins." This lucky fellow actually did find a valuable hoard. But he spent 2½ years in Old Mexico before he hit paydirt. Still, you can find valuables; all it takes



Detectors are handy at home, too. They help locate pipes, storm drains, or buried steel tanks, saving you many hours of digging. Contractors and surveyors also use detectors.



Scanning walls and ceilings is done the same way as floors: Detector head is held parallel, a few inches away.

is a reliable detector, a little experience—and plenty of luck.

What is a metal detector? As the name implies, it's an instrument that detects buried metal and conductive minerals. No black magic is involved. It's simply a transmitter and receiver of electrical impulses. By inducing a short-range electromagnetic field, the instrument detects changes in the electrical conductivity of the area it passes over. The detector "reads" gold, silver, copper, iron, and other metals.

The detectors used by weekend treasure hunters are usually compact, short-ranged, and ultrasensitive. Don't expect them to locate paper money, priceless gemstones, or anything else nonmetallic. Nor can they tell the difference between gold bullion and bottle caps. The detector can find ore deposits—but it can't tell you whether the ore is gold or iron.

Using the detector. The average detector has a round head about an inch thick and the size of a large meat platter. An attached carrying handle helps you keep the head parallel to the ground. A transmitter-and-receiver box is attached on top of the carrying handle.

Detection is both visual and auditory. When the head passes over metal, the register needle (mounted on the control box) crashes hard right, fluttering wildly. Earphones worn by the user go from a low, steady hum to a loud one. By stepping back and forth and sideways, you can pinpoint the exact location of the buried object. The detector will read through ice, concrete, wood, and earth.

It has limitations, however. It can't tell you what the object is, how deep it's buried, or whether it's valuable. There's one way to find out: with a spade.

Depth range. Detectors are made to find either large ore deposits deep down—as much as 30 feet—or small items such as guns, rings, and coins near the surface. You can't get maximum depth range and ultimate sensitivity in the same instrument.

The following factors influence depth range:

- The surface area of the deposit. Large, bulky, metallic objects lying flat are easy to detect down to about 30 feet. The same object edge up might be detectable no farther than two feet.
- The moisture content of the ground.
- The length of time an object has been buried. After a couple of years, the immediate area around a metallic object provides three or four times the area of conductivity, and readings are easier to spot.
- The type of instrument being used.

Representative of the new breed of detectors are the Metrotech, Fisher, Detectron, Raytron, Goldak, Geo-Finder, and others. All use the same principle. But operation, depth range, balance, and sensitivity vary tremendously. The differences are readily apparent. For example, you can get many kinds of carry-



Most detectors have about the same depth range, but sensitivity varies greatly from brand to brand. Shown from left to right are Metrotech, Geo-Finder, Detectron, and Goldak.

ing handles. But what really matters is balance. A unit that's hard to hold parallel to the surface will cramp your arms. Bulk is another consideration. The new transistorized detectors, such as Metrotech, weigh only 3½ pounds. Prices range from about \$75 up to \$250.

The basic types. Almost all weekend treasure hunting is done with transistorized, tube-type, or surplus military detectors.

Transistorized detectors can take rough treatment. Most use standard lantern batteries, which are good for 150 to 250 hours of continuous duty. Cost of operation: ½ to 2 cents an hour. Depth range isn't as great as that of tube-type units, but sensitivity near the surface is amazingly good. Goldak claims its detector can locate a silver or gold ring buried at three inches; medium-sized gold or silver coins at eight inches; and an iron kettle filled with coins or other metal objects at four feet.

Until a few years ago, the tube-type

[Continued on page 202]

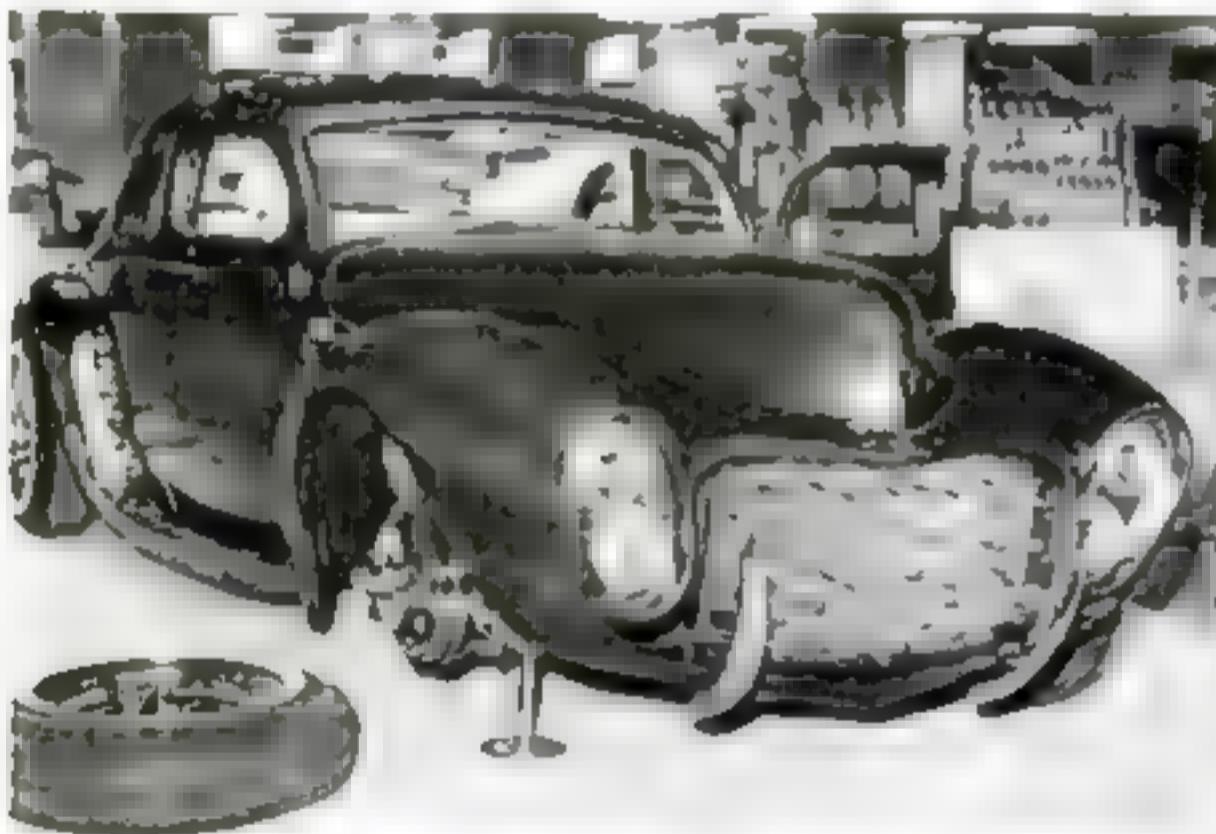
Back-yard engineers build way-out rods and customs

No matter where Detroit puts that strip of chrome, or how much horsepower they pack under the hood, there are always people who aren't satisfied. A few—the hot-rodgers and customizers—do something about it.

When some of their weird and wonderful creations converged on New York City recently for a national show, PS was there. Entries included cars designed for every-

day transportation and for drag-strip competition. Some are so valuable that they are never driven; they're towed to and from shows.

Many are so extensively modified that their origin is unrecognizable. A few, including the dragster shown here (far right, center of page) were built literally from the ground up.



The hood is the only hint that this is a 1940 Ford. A strip was cut from the body at the center line and the two halves welded back together for sleeker appearance. The top was cut down. Right front wheel is off to show chromed brake drum. Quad lights and custom grille are new. An Oldsmobile engine powers the car.



Latest of bubble tops is this dream car with hand-formed metal body over Buick chassis. Engine is modified and fuel-injected Buick V-8. Canopy can

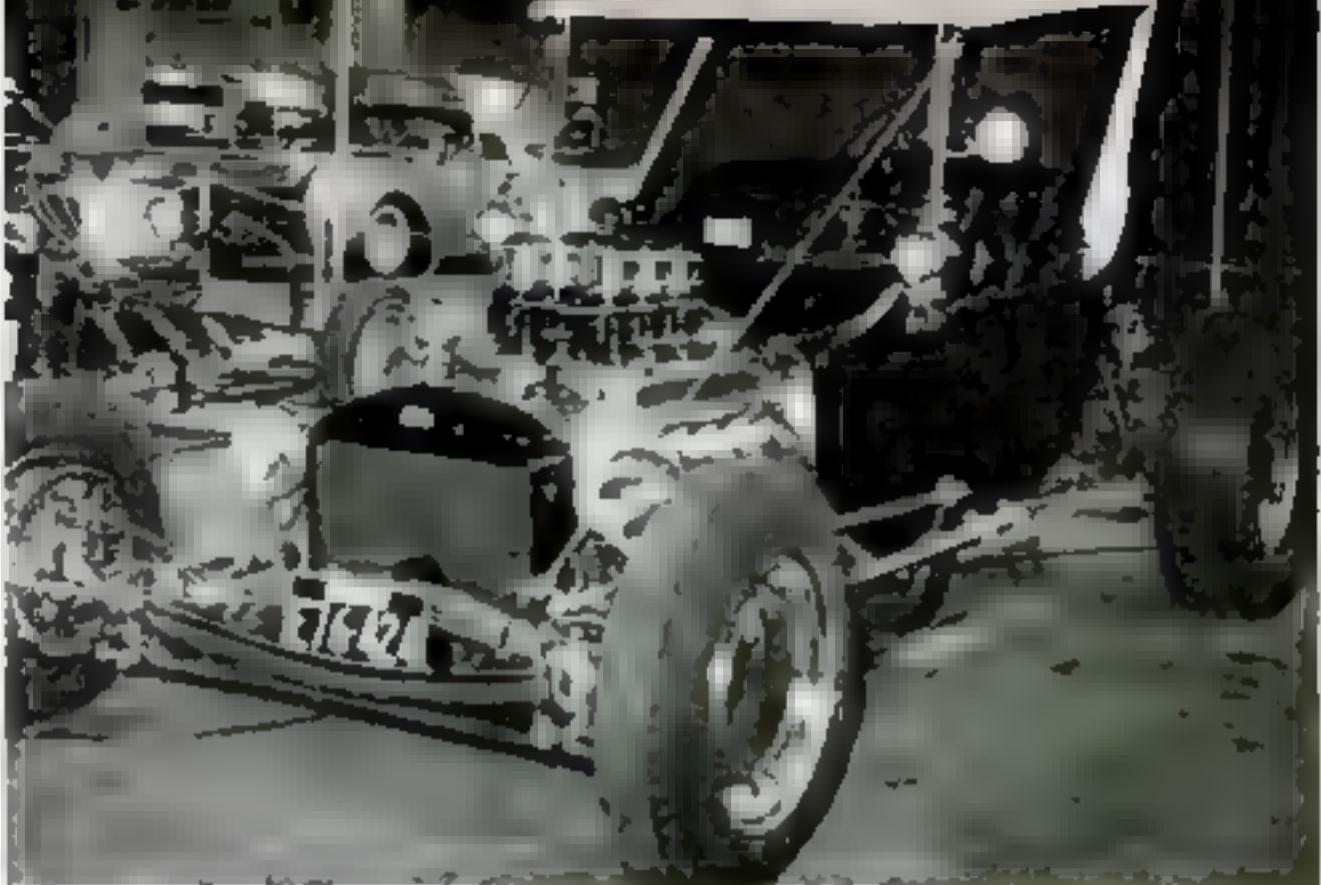


Seaplane skims on hydrofoil

The Navy is now trying hydrofoils on seaplanes, as part of a test program to improve operation in rough water.

The single high-speed hydrofoil, mounted between two ventilating struts, is located below the center of gravity of this JRF-5 Grumman Goose (borrowed from the Coast Guard). Two bow skis stabilize the plane during landing and takeoff, and prevent diving in case of damage to the hydrofoil.

1955 Buick V-8 engine takes place of weary 4 in this Model T roadster. An overbore increases its displacement to 352 inches for greater power. Highly chromed engine has six carburetors. The car was shortened and narrowed, and the body channeled (lowered) over the frame rails.



be opened and all instruments operated from outside. Cable at lower right leads to remote-control box. Finish is multicoat maroon lacquer.

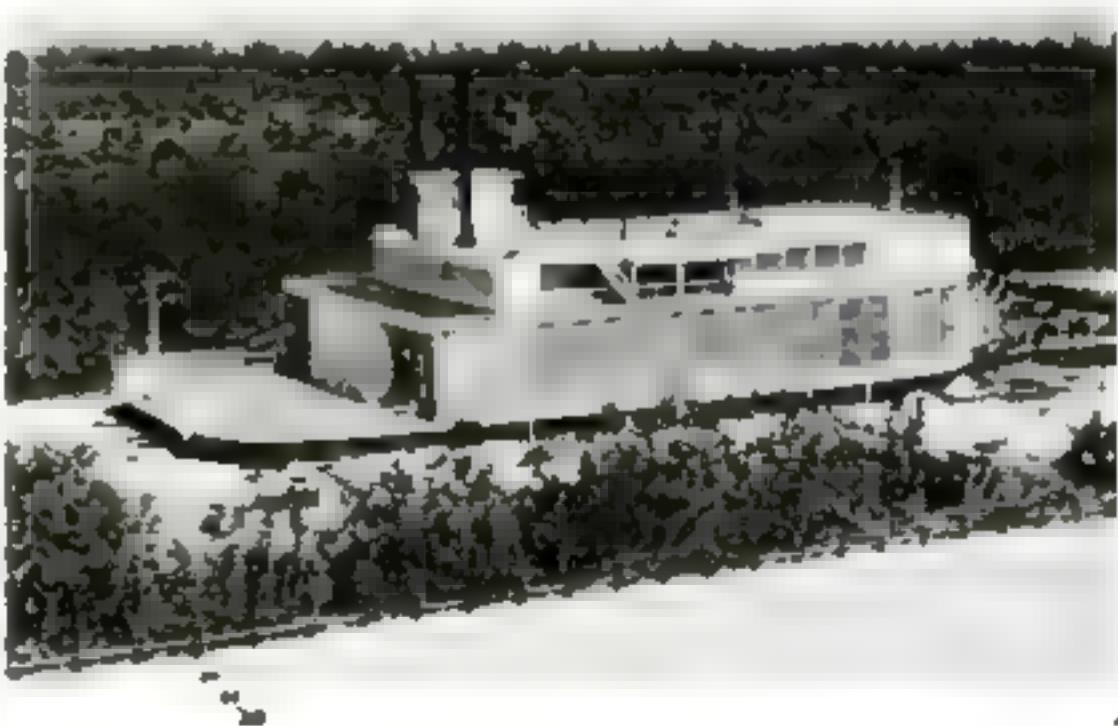


For better rear-wheel traction, engine of hot rod above is set back and driver sits behind rear axle. So car would qualify for its class, displacement of fuel-injected Chrysler V-8 was reduced to 299 inches by inserting sleeves in cylinder bore. Dragster does a standing-start quarter-mile in a hot 10.8 seconds.

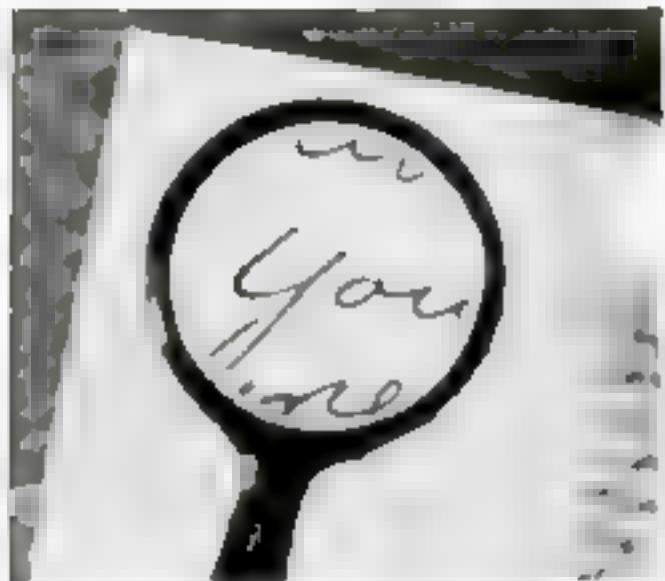
Landlocked sternwheeler

Retired after years on the Mississippi, the Algiers (right) has become a palatial residence on the Florida beach at Sanibel Island. Its site: a 1,000-foot stretch of beach beside a little inland pond.

To get the boat to the site, a quarter-mile channel was cut from the Gulf of Mexico, and she was inched in with the aid of bulldozers. Then tons of sand and crushed shell were dumped in for a foundation.



Does Your Handwriting Give You Away?



Science? Quackery? Here are today's facts about the art—over a hundred years old—of reading personality from handwriting

By James R. Berry

DOES your handwriting tell anything about your personality? For decades most educated people have scoffed at the very notion, lumped graphology—analyzing personality from writing—with astrology, palm reading, and other forms of hocus-pocus. Today, though, the tide may be turning. Take these cases for example:

• Last May, 13 Bangor, Me., bankers finished a course in handwriting analysis. Now they're using it to judge a borrower's honesty, to hire tellers who are good at details, even to estimate a client's business sense.

• A trucking firm hired a graphologist to spot accident-prone drivers, claims it's cut crashes and reduced insurance rates.

• A St. Louis diamond dealer recently had an outbreak of thefts. Suspecting an inside job, he sent writing samples of

his 15 employees to a graphologist. A day later the analyst had singled out the most likely suspect. A week of watching this employee's every transaction proved the expert right.

• The director and chief probation officer of an Illinois family court, Charles F. Martin, claims handwriting analysis is less trouble and as good as psychological tests in marital counseling and understanding adolescents.

Have these people been duped by clever quacks, or been so enticed by the prospect of interpreting handwriting that they have lost perspective? Or is graphology actually an underestimated science?

Unlike palmists, astrologists, and other occultists, handwriting analysts don't say they can, or want to, tell fortunes, read thoughts, or predict the future. They do claim, however, that your writing reveals:

• Intelligence, emotional stability,

Giveaways? How you write your name shows how you want the world to see you, say graphologists. Here are some famous signatures. First column: Franklin D. Roosevelt, Harry Truman, Walt Disney, John F. Kennedy. Top of second column: Napoleon (note heavy-pressure underscoring). Below Dwight D. Eisenhower's signature are three samples indicating Benito Mussolini's self-inflation: First one was written when he was a little-known journalist, then, coming to power, he spread himself and dropped his first name (swelling ego). Finally, he joined Hitler against the world, and his self-importance showed up in a huge signature with tremendous pen pressure.

Franklin Roosevelt Nancy

Dwight Eisenhower

Harry Truman

Benito Mussolini

Walt Disney Martin

John F. Kennedy

Murphy

imagination, ability to work with others.

- Capabilities and unsuspected talents.
- Personality strengths and weaknesses.
- Many kinds of mental and physical illnesses.

Just what are the bases for their claims?

Writing, declare the graphologists, is more complicated than we think. The impulse to form a letter begins in the brain's writing center—in the cortex. This center, akin to the brain areas that control vision, hearing, talking, and walking, guides the muscles as they weave through the complex movements that make words. Since writing begins in the mind, emotions and attitudes, both part of the mind, influence how we write, just as they influence how we walk and talk.

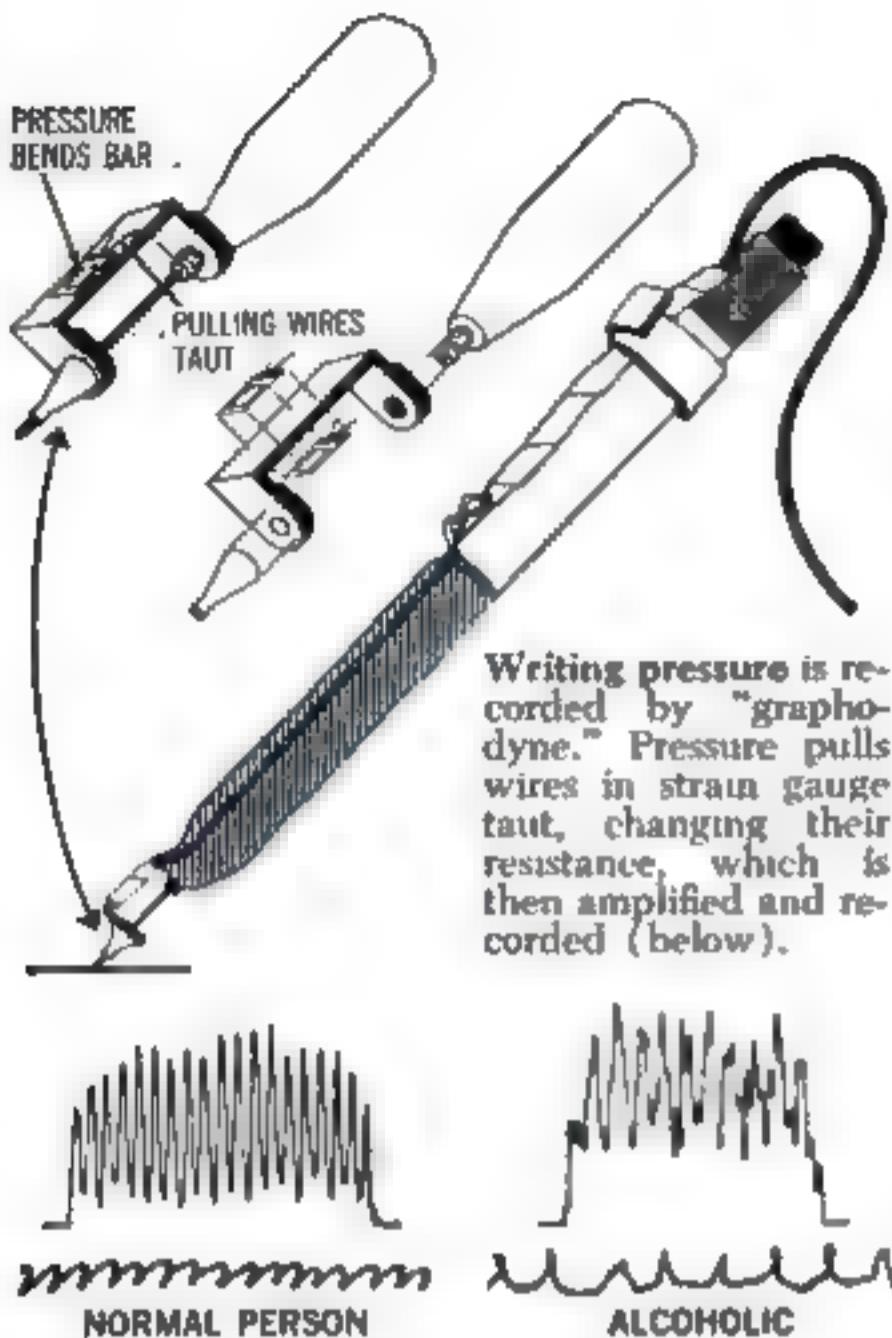
Take signatures. The way you sign your name unconsciously shows how you

want the world to see you. The body of a letter reveals what you're really like. A large, ornate signature following tiny script very likely means the writer is outwardly an extrovert, but feels in-

CONTINUED



Six lines of writing enabled expert Norris J. Starkey of the Indianapolis police department to identify a criminal. Your handwriting, experts claim, is as individual as your fingerprints.



Writing pressure is recorded by "graphodyne." Pressure pulls wires in strain gauge taut, changing their resistance, which is then amplified and recorded (below).

NORMAL PERSON

ALCOHOLIC

wardly insecure. A tiny autograph after large letters indicates the writer is modest, has more to him than a first meeting indicates.

By combining the meanings from dozens of writing traits such as signatures, slant, speed, and word spacing, the analysts assemble a personality portrait. But, they add, no one sign or group of signs is conclusive by itself. Often, one writing trait changes the entire meaning of another.

Illegible writing. Writing that's hard to read generally points to indifference, laziness. But add extreme writing speed, and the picture changes. If the writer whizzes along, his mind is miles ahead of his hand. His script tries to keep up, becomes illegible.

Graphologists say they need a page or two of writing and a signature to give a thorough analysis. But even scraps of writing tell a lot.

Not long ago an Indianapolis businessman was swindled out of several thousand dollars by a confidence man. Police got a tip that the gyp artist lived in a

nearby hotel. When they arrived he had already skipped. Their only clue: a hotel registration card with a few lines of writing.

The detectives turned the card over to Norris Starkey, member of the force and a handwriting analyst. Starkey studied the writing. The crook, he declared, was well educated, intelligent, and had extraordinary planning ability. He was a smooth talker, dressed well, and remained calm in emergencies.

The police soon hauled in a felon who tallied with this description. Warned by Starkey that he probably had a well-prepared alibi, they weren't fooled by his answers, kept shooting questions until he finally broke down and confessed.

Hiring by handwriting. Many industries think enough of graphologists' claims to use handwriting analysis in hiring personnel. Albert Nickerson, a vice-president of Socony Vacuum Oil Company, found in a survey of 78 corporations that 90 percent of discharged employees were fired because of personality problems. Today, scores of companies throughout the country say they avoid this trouble by using handwriting analysts to weed out applicants who won't get along with fellow workers.

Firms using graphology don't broadcast it. But when an ad states: "Answer in your own writing," the chances are fairly good that your script will get a careful scrutiny.

"Often we have to hire overseas help sight unseen," reports an executive of a giant industrial corporation. "A mistake can be costly. By using graphologists to check applications, we avoided hiring several persons who we now know would have been bad choices."

Emotional troubles and mental diseases turn up in handwriting, too, say graphologists.

Not long ago, the *American Journal of Psychiatry* had an article by psychologist William R. Perl stating: ". . . there is an intricate and interpretable relationship between a person's emotions and his

[Continued on page 196]

What the experts watch for in analyzing handwriting

According to graphologists, chances of two identical handwritings are several billion to one. Dozens of different traits go into each person's script, but four traits, common to all writing—stand out. Here's what handwriting analysts say about them.

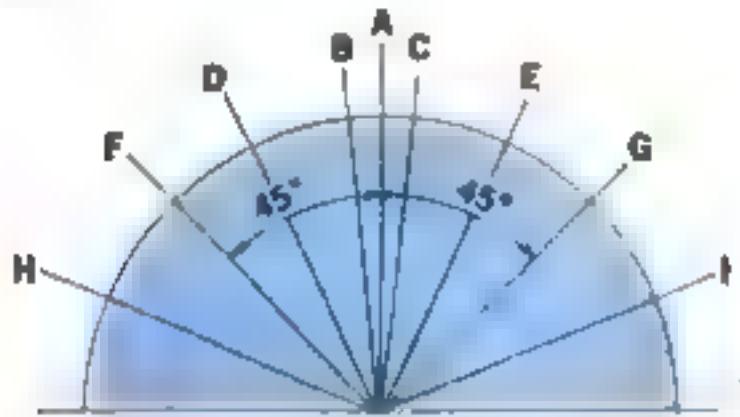
PRESSURE

Writing pressure has nothing to do with physical strength. Men who can crack walnuts in their fingers often write very lightly, some 90-pound women write as if wielding a pile driver.

Heavy, uniform pressure indicates mental "get-up-and-go" power, drive, and zest—an ability to handle five projects at once and start another.

Minuscule writing would smear if pen pressure was heavy. In this case mental energy is indicated by uniform light pressure in combination with speed and regular spacing.

SLANT



Vertical writers (A on the scale) resist the natural inclination to slant to the right, reveal they can hold emotions in check and use logic in making decisions. A pronounced backhand writing (F or H on the scale) points to bottled-

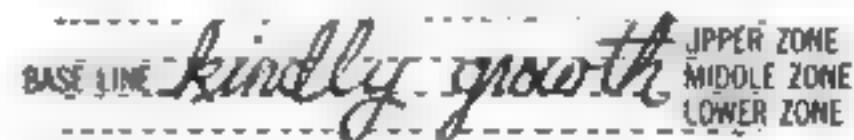
up emotions, secretiveness, and stubbornness. The other extreme (I) is the mark of extreme emotional instability.

WRITING SPEED

Fast writing marks a quick (but not necessarily accurate) thinker and talker. If letters have original shapes yet are simplified to cut down writing time (these qualities taken together make what graphologists call the "form level") the writer is intelligent. Form level and writing speed provide clues to how fast and how accurately a person thinks.

ZONES

Even parts of single letters disclose inner attitudes. The upper zone reflects imagination, idealism, intellectuality. Artists, writers, and people with strong convictions make origina-



shapes here. The middle zone reveals your attitudes towards others and how you face everyday problems.

The lower zone divulges your sexual and material drives. People who like high living and money will make well-formed and lusty shapes in this area.

One more common characteristic: margins. A thrifty person—one who'll squeeze an empty toothpaste tube for days—instinctively uses up all his writing paper. His margins start near the paper's left edge and run close to the right one; the lines of script are close together.

If the left margin becomes wider farther down the page, a native sense of generosity is winning the battle over economizing. If the margin starts wide and narrows toward the edges later, he's just the opposite.

What "T" formations mean to graphologists

 Inflated loop means a person is sensitive, quick to feel hurt.

 Tied stroke at end shows persistence, stick-to-it spirit.

 Short, thin, and weak crossing indicates a lack of will power.

 Heavy, long, strong crossing goes with strong will power.

 Cross stroke fading beyond stem means a fading will power.

 Bow-shaped crossing is associated with a person's self-control.

 Slanted, arrow-shape crossing shows a domineering person.

 Above-stem crossing goes along with a person of vision.

 No crossing at all reveals a person is careless about details.

 Hook-at-end of crossing is sign of hang-on ability, tenacity.

 Hook at beginning of crossing shows writer is acquisitive.

 No initial stroke indicates straight-talk, direct approach.

 Tent-shaped stem is interpreted as an indication of stubbornness.

 Basin-shaped crossing means a person has a shallow nature.

 Separated stem shows the writer as one of deliberate action.

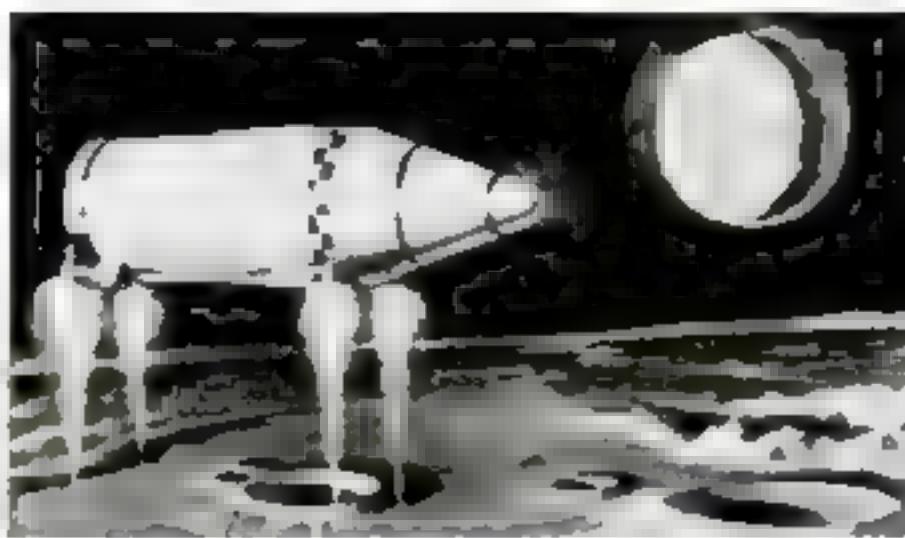
 Stem-stopping crossing means put-it-off procrastination.

 To-the-right-of-stem crossing is a sign of temper in a writer.

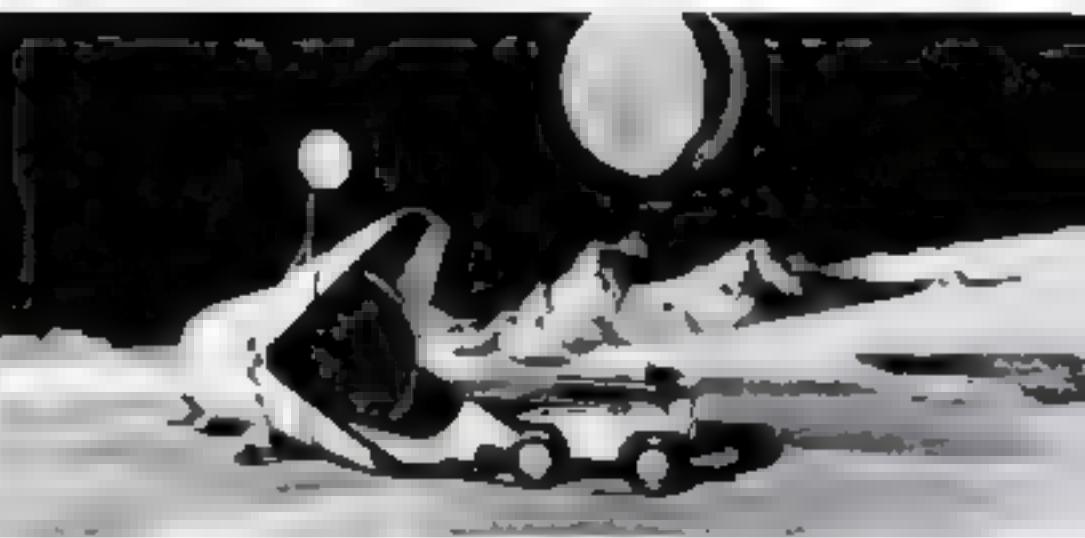
 High-on-stem crossing means a high or distant goal in life.

 Halfway-on-stem crossing shows person has a practical goal.

 Low-on-stem crossing reveals that no goal has been established.



Soft landing on the moon with aid of hover and landing retrorockets is depicted by artist.



Nose cone opens wide, and robot rolls out, towing nuclear reactor that provides power.

Lunar housing for early arrivals

When man makes it to the moon, he'll need a place to live—and quick. Douglas Missile and Space Division proposes to send a robot on ahead to prepare a shelter for protection against meteoroids, radiation, and temperature extremes. The robot would be an all-purpose vehicle controlled by telemetry and monitored by television. It would land in a rocket nose that would

serve as the astronauts' earliest shelter. Its first job would be to set up a portable nuclear reactor for power and communications. Then, acting like an earthbound snow blower, it would scoot around the shelter, scooping up lunar soil and spraying it on the nose to bury it.

For later lunar explorers, North American Aviation's Space Systems Division



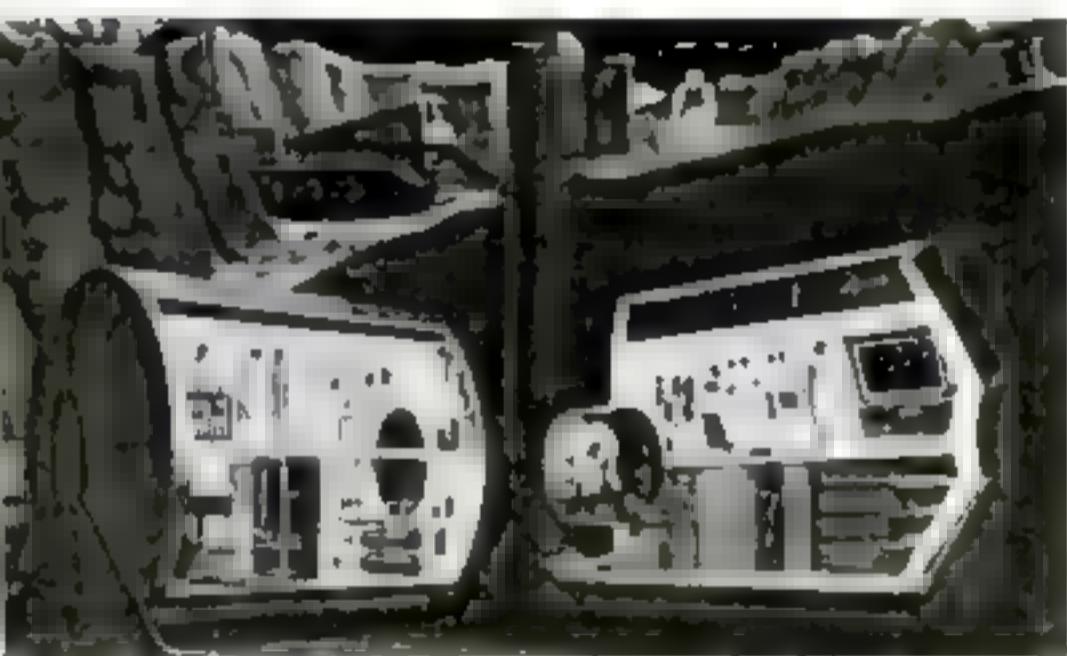
Wheel spokes in model above are empty booster tanks that serve as quarters for astronauts. Run

of nuclear reactor. Shelter contains enclosed oxygen converters and 2 tridents to grow food

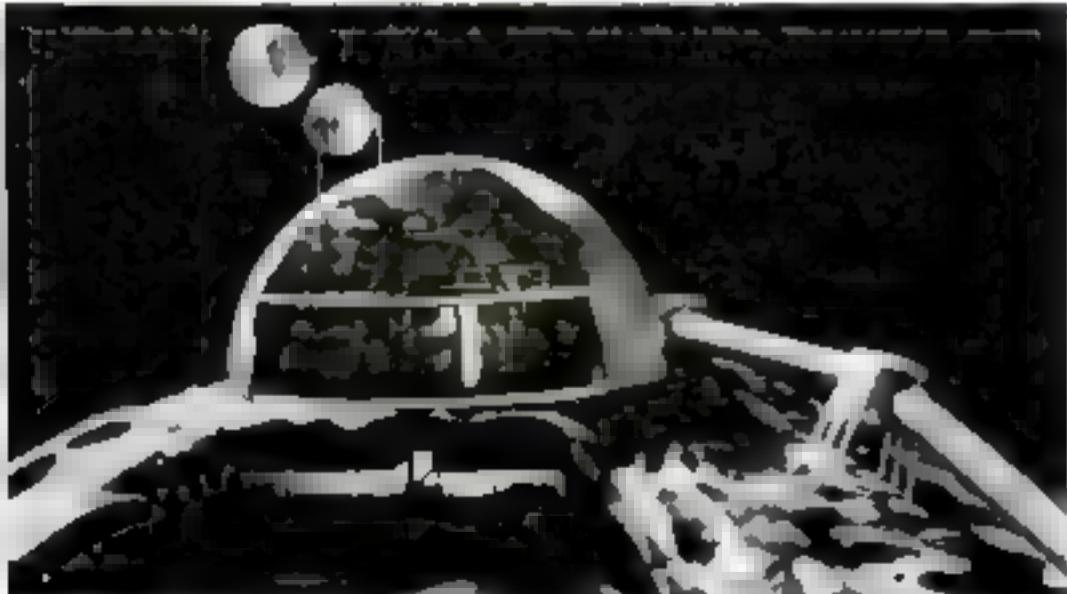


Lunar soil is scooped up, blown over shelter. TV camera on tripod near spout monitors work.

visualizes a self-sufficient colony (below). It would be built from rocket-booster tanks radiating like the spokes of a wheel from a communications hub. They would contain living quarters, medical center, recreation areas, and shop facilities. Ringed around them would be enclosed gardens to provide food and to convert carbon dioxide into oxygen. A water-conversion plant would be set over a fissure from which volcanic rock would be mined through a vertical shaft, crushed, and heated to extract up to a gallon of water per cubic foot.



Cutaway of buried booster tanks shows how they may be arranged to care for explorers' needs.



Water-conversion plant covers a fissure from which volcanic rock may be processed for water



Water jet swivels to steer no-prop, no-rudder, shallow-draft experimental boat.

Wankel rotary engine pushes these new boats

The Wankel rotary engine [PS, Mar. '60] has finally found practical use—but not in a car. A 43-hp. version powers the Swiss experimental jet boat above. Pumps suck up water from the underside, exhaust it under pressure.

A smaller 21-hp. Wankel engine pushes the Ski-Craft below, a German water-skiing device, at up to 27 m.p.h. The Ski-Craft will be sold by Trans-continental Motors in New York for over \$1,000. A larger Wankel will appear this fall in a German NSU car.



Ski-Craft has grab handles attached to control box. A gallon of fuel lasts an hour.

Millions of exciting chances are opening up for bright young men as fast-growing new industries holler for help

Should You Try for a Better Job?

By Herbert Yahraes

"I'm eager to get ahead. I read about the scientific and technical revolution—space, atoms, electronics. What opportunities does it open up for me? How can I find out which jobs I might do best in? How can I get training for work like that and keep on supporting my family?"

THIS plea, from a young shipping clerk in Michigan, is typical of hundreds of letters received by POPULAR SCIENCE. The editors asked me to find the answers. I talked to personnel directors at big corporations, training experts, the heads of schools, business executives, and government officials. What they told me will open your eyes. They pointed out the big, new chances, and explained how recently developed training programs—in technical institutes, adult-education groups, correspondence schools, corporation study plans—help ambitious young men latch onto those chances.

Now is the time

While automatic machinery takes over farming, old-fashioned factory production, and office routine, the new fast-growing industries are cry-

ing for help. Here are some hot areas:

- Space research—the boom industry of the Sixties—employs well over 1,000,000 people *but was short 40,000 or so this year* and will need more and more for years to come.
- Construction, of homes (more than 1,000,000 a year) and of everything else from supermarkets to launching pads, requires 3,000,000 men. By 1970 the number will be 4,000,000 to 5,000,000.
- Service work keeps multiplying—automotive, TV, home, commercial, government. Today there are 33,000,000 jobs in this field; by 1970 there will be 7,000,000 to 10,000,000 *more*.

Don't worry if these fields seem strange to you. A Washington acquaintance of mine, Chuck Billings, had been a Navy machinist for 18 years when the plant closed down. He could have transferred to another

government shop. But he had a secret hankering to get into sales. He lined up a job selling power tools to hardware stores. His wife says, "He's become a nice guy again."

Chuck is no exception. Official statistics show that 8,000,000 workers change their jobs in a typical year. Two-thirds of them go to different industries. And half switch to completely different occupations.

Advanced jobs take advanced training

Space-age industries eat up all kinds of skills, from cooks and bakers to machinists and tool checkers. But they're hungry for specialists:

- Pipe fitters (qualified on lox and hydrazine lines).
- Electricians (for exotic power systems).
- Cameramen (on telescopic tracking cameras).
- Chemical-plant operators (to cast solid fuels).
- Radarmen (to set orbits).

The best-paying, fastest-promotion spots are open for men expert in the newest techniques. In a government-sponsored training program for computer specialists, 600 students had jobs sewn up *before graduation*.

Construction-machine operators are in heavy demand. Today even ditch-digging, once a synonym for the most menial of work, is a highly skilled occupation; the modern ditch-digger commands a complex, expensive machine and averages around \$4 an hour.

You get the idea just by skimming the help-wanted ads. Here's a sampling from one paper:

- Auto mechanic (alignment) — \$150 a week.
- Construction estimator.
- Die-casting die-makers — \$3.50 per hour.

● Sheet-metal draftsmen — \$150-\$175 a week.

● Computer technician — \$150 a week.

● Engineering aides — \$120 a week.

● Metal spinner.

● Plumbing estimator.

● Heli-arc welder (stainless steel).

● X-ray technician.

● Wiremen — \$3 an hour plus heavy overtime.

One study, by International Correspondence Schools, shows that 500,000 skilled jobs will open up this year alone.

And the prospects for technicians—men with one or two years of basic engineering training after high school—are fantastic. Technicians handle most of the detailed design and construction of complex equipment. Every graduate engineer should have two technicians working with him—a potential of more than 1,500,000 jobs. Yet today there are less than a third that number of technicians in the U.S., and only 16,000 new ones are being turned out each year.

Training waits for you

You can't just fall into jobs like those. But never before have there been so many opportunities to prepare yourself to win them. Here is a quick rundown:

If you like the company you work for now, ask about training for a better job right there. Some corporations, like Martin in Baltimore and IBM in Poughkeepsie, N.Y., have set up courses close to the plant. At Ford, more than 20,000 employees take studies ranging from apprentice training to full-time university schedules.

Home-study courses are the most convenient training. They bring the school to you, and let you train in

[Continued on page 204]



Hesitantly, I accept a space suit from GE's Carl R. Cording. Outfit formerly belonged to ex-GE test pilot Elliott See, one of the new astronauts.



America's first chicken astronaut (me) starts to sweat—combination of an airtight suit and nervousness. (After test, I decided to remain a terranaut.)

I went for a spin in a Weightless Workshop

By Robert Gannon

WRENCH gripped tightly, I yanked down, trying to loosen the nut. It didn't budge—but I did, swinging evenly, flipping head over heels in my space suit. I lunged at the side of the craft, missed, and slowly floated away, helplessly.

I wasn't in zero-gravity space, of course, but on a device that comes darn close to giving that sensation. It's called the Spaceworker, or, more formally, Five-Degree-of-Freedom Simulator. General Electric's Missile and Space Division put it together to see how well a man in orbit can work outside his ship.

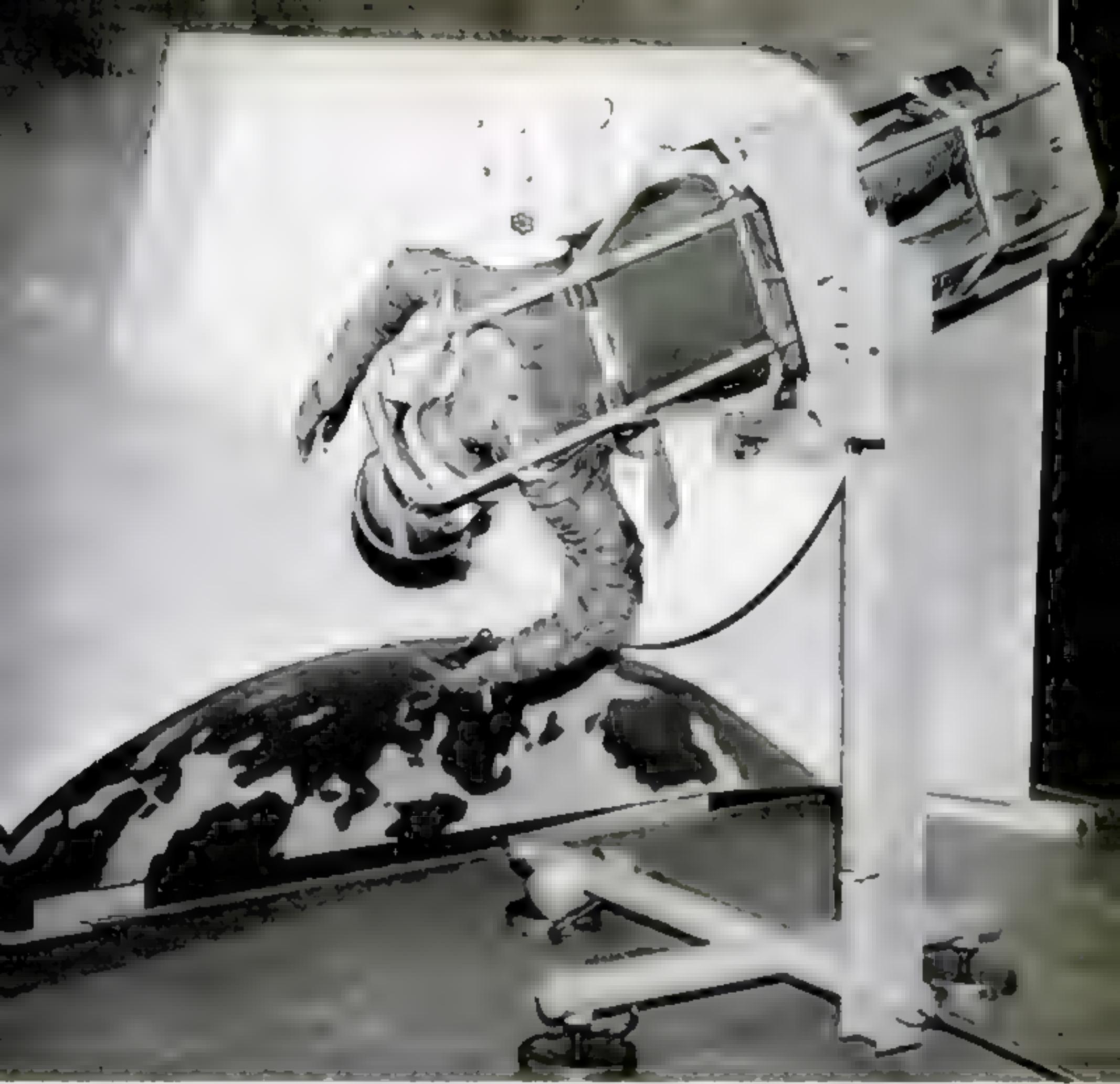
Spaceworker is a simple contraption—a basketlike stretcher balanced in gimbals, a yolk attached with ball bearings to a three-footed post. The whole thing is kept floating just off the floor by three frictionless air bearings, disks with holes through which air flows to hold them up like flapjack-size hovercraft.

Strapped in the simulator, you pitch, yaw, roll—even spin, if you want to. In fact, Gene Day, the lab supervisor, once got himself revolving at 27 r.p.m. (On the 44th revolution he got sick.) Gravity isn't absent, of course, but that doesn't seem to make much difference.

Before I got aboard, Carl R. Cording, manager of GE's Valley Forge (Pa.) Manned Spacecraft Laboratory, helped me squirm into a space suit.

I didn't feel like an astronaut, but my walk to the lab took me through the lobby,

[Continued on page 218]



Top-heavy, I flip head-downward. Adjusting for exact center of gravity can be tedious.

With nothing to push against, I couldn't "jump" or pick myself along—could only turn on my axes. Here I wait to be pushed to mock-up capsule.

Simulated problem-removing nut—is easy if you get hang of using body mass for leverage.



Now—a Jet Boat That Goes Sideways!

Thrust from two jet ports, one at the bow and one at the stern, eases this new craft into the dock

By Hubert Luckett

THREE'S now another trick to add to the impressive list of things you can do with a jet-drive boat that you can't do in any other: move sideways.

A new jet by Upson Marine has bow steering. With it, you can forget the aim-and-pray routine when docking in heavy wind or current. Instead, you just take your time and sidle into a crowded berth as casually as a woman shopper inching in ahead of a man at a checkout counter.

The basic propulsion unit is a single-stage, axial-flow pump. It is available in six different models to match engine sizes ranging from 40 to 275 horsepower.

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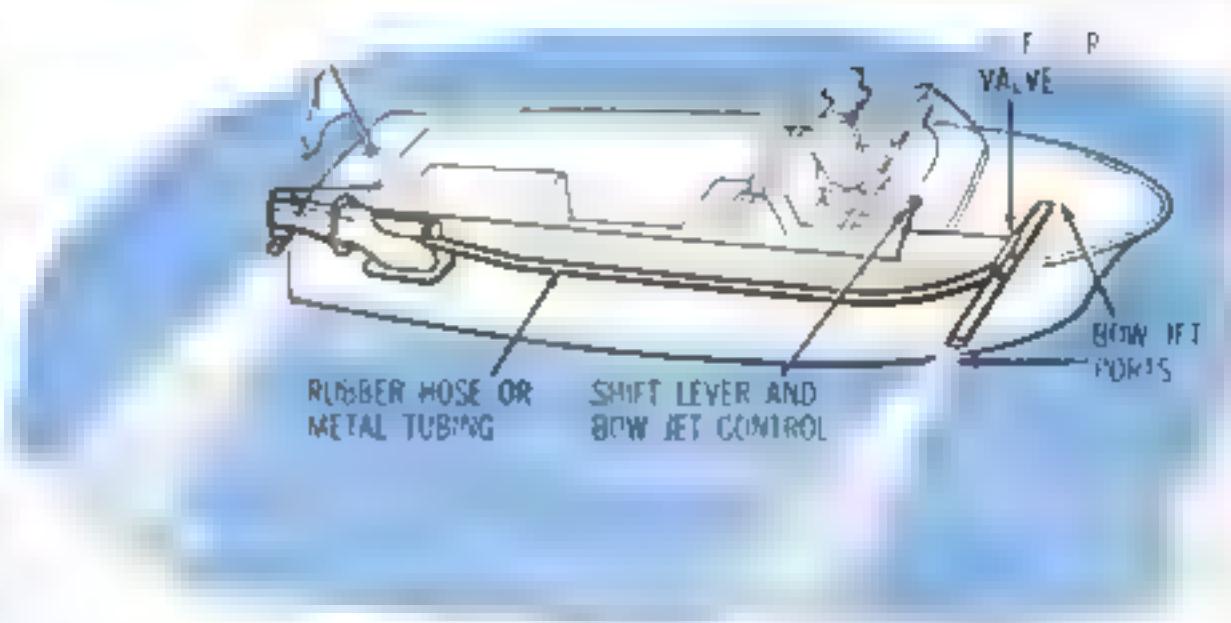


Powered sideslip is accomplished by turning reverse jet to one side and opening the valve to the bow jet on the same side. You can control bow and stern independently.

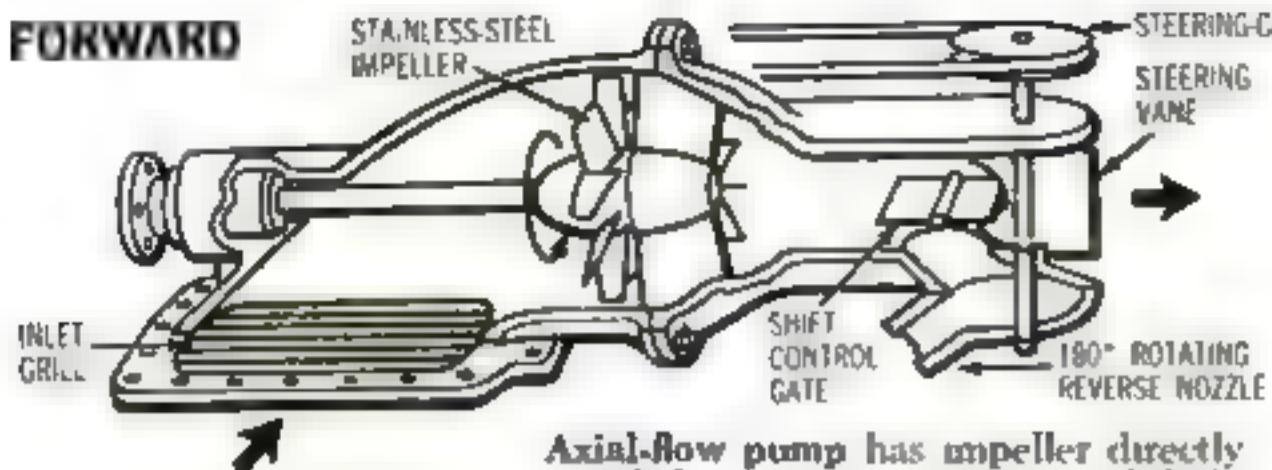
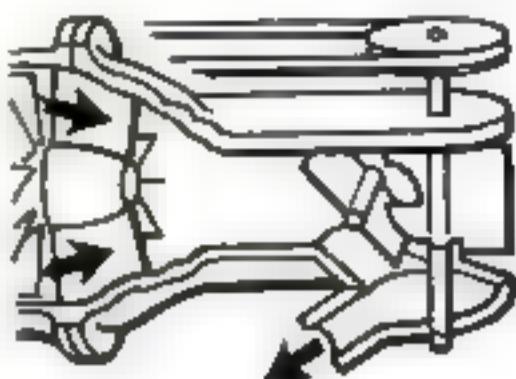
Pinwheel maneuver lets you spin boat in its own length. Reverse jet is turned to one side with wheel, and bow jet on opposite side is activated. Other bow jet stops the spin.



Shift lever controls bow jets when moved sideways, and forward, neutral, and reverse position of control gate when moved fore and aft



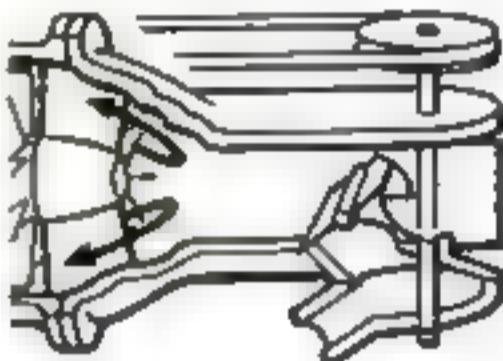
Bow steering system for low-speed maneuvering uses auxiliary jets on either side of the bow. Water under pressure is supplied through a rubber hose or metal tubing from an outlet on the side of the jet pump. Operating pressure is applied to this line when the control gate is in the reverse or neutral position.

FORWARD**REVERSE**

Taking a look inside the jet-drive system



Axial-flow pump has impeller directly coupled to the engine crankshaft. Shift control gate is operated by lever at driver's seat. Above, control gate is shown in forward position. At top right, gate is in reverse position with water diverted into reverse nozzle, which rotates with the rudder.

NEUTRAL

Nozzle housing can be removed if necessary without taking boat out of the water. Rudder and control gate of balanced design require little force to operate — any cable-and-pulley, single-cable push-pull, or drag-link system will tie them to wheel and shift lever. Elbow at side of housing is for bow jet supply.

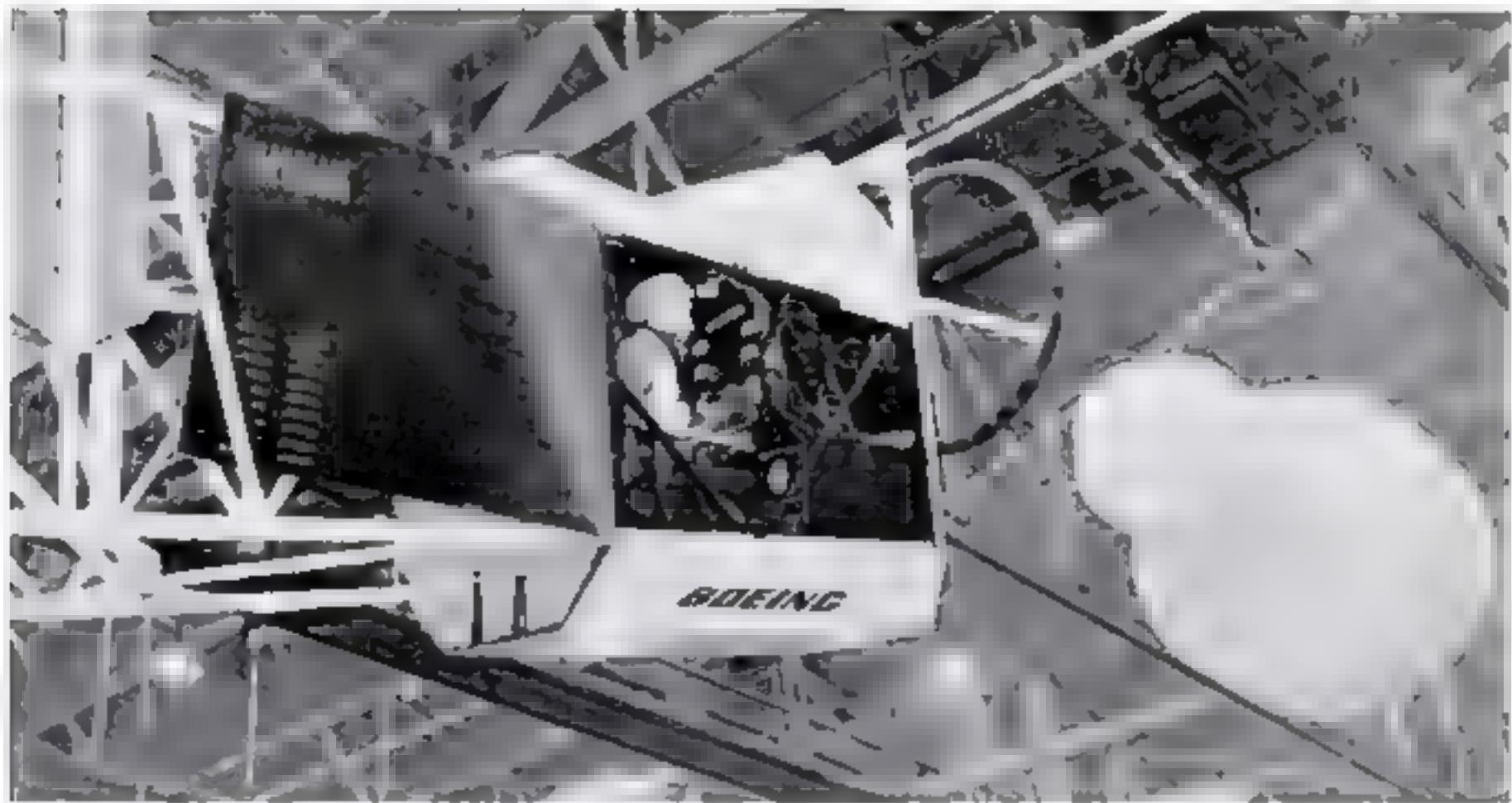
In a jet boat, thrust (the force that drives the boat) is created by accelerating a large volume of water. One model of the Upson jet will deliver 4,000 gallons of water per minute at 4,000 r.p.m. The manufacturer claims acceleration from 0 to 30 m.p.h. in six seconds and top speeds of over 50 m.p.h.

The bow steering. This trick is handled by two ports, one on either side of the bow at the water line; a selector valve that directs water flow to one or the other of these ports; and a hose that delivers water under pressure from the jet unit. Bow steering is used only for docking or maneuvering in tight places. When the boat is under way, a vane in the main jet stream gives steering control. For reverse, the stream is diverted to a swiveling nozzle on the lower end of the rudder post.

The Upson Marine jet unit can be installed in almost any existing hull fitted with

an engine of the specified horsepower. Special mounts and transom angle-adjustment wedges simplify its adaptation to the hull, regardless of design and construction, so long as a smooth flow of solid water can be maintained to the unit's inlet. No special tools or skills are required to install the jet system. Only two openings are needed: one through the bottom for water intake and one through the transom to take the jet nozzle.

The unit weighs only 136 pounds, so the dead weight your boat must carry will be reduced over most standard prop drives. The jet drive saves space inside the boat, too. The 8" models need only 18", and the 10" sizes only 21½". A special intake grille keeps weeds and debris out of the pump. And, of course, jet boats have no props, struts, or rudder projecting under the hull to create drag or get fouled on rocks or snags.



Learning how to rendezvous in orbit

Future astro pilots are now getting realistic practice in the tricky technique of coupling two spaceships in orbit—while remaining safely earthbound. In a Boeing-developed simulator, one "rocket ship" is a cabin mounted on a frictionless bearing that permits the pilot to produce the motions

of pitch, roll, and yaw while positioning for rendezvous with another "ship" suspended from a crane. He controls this one through a computer to simulate the effect of rocket reaction. His goal is to maneuver the nose of the forward "space capsule" into a rubber ring in front of his cabin.



New midget scooter: transportation or fun

This tiny scooter squeezes 125 miles from a gallon of gas and makes 35 m.p.h. while doing it. The Wren has a 38-inch wheelbase, weighs 62 pounds, costs \$100. An automatic centrifugal clutch is standard. Bird Engineering, Omaha, Neb., builds it for hunting, errands, or just fun.

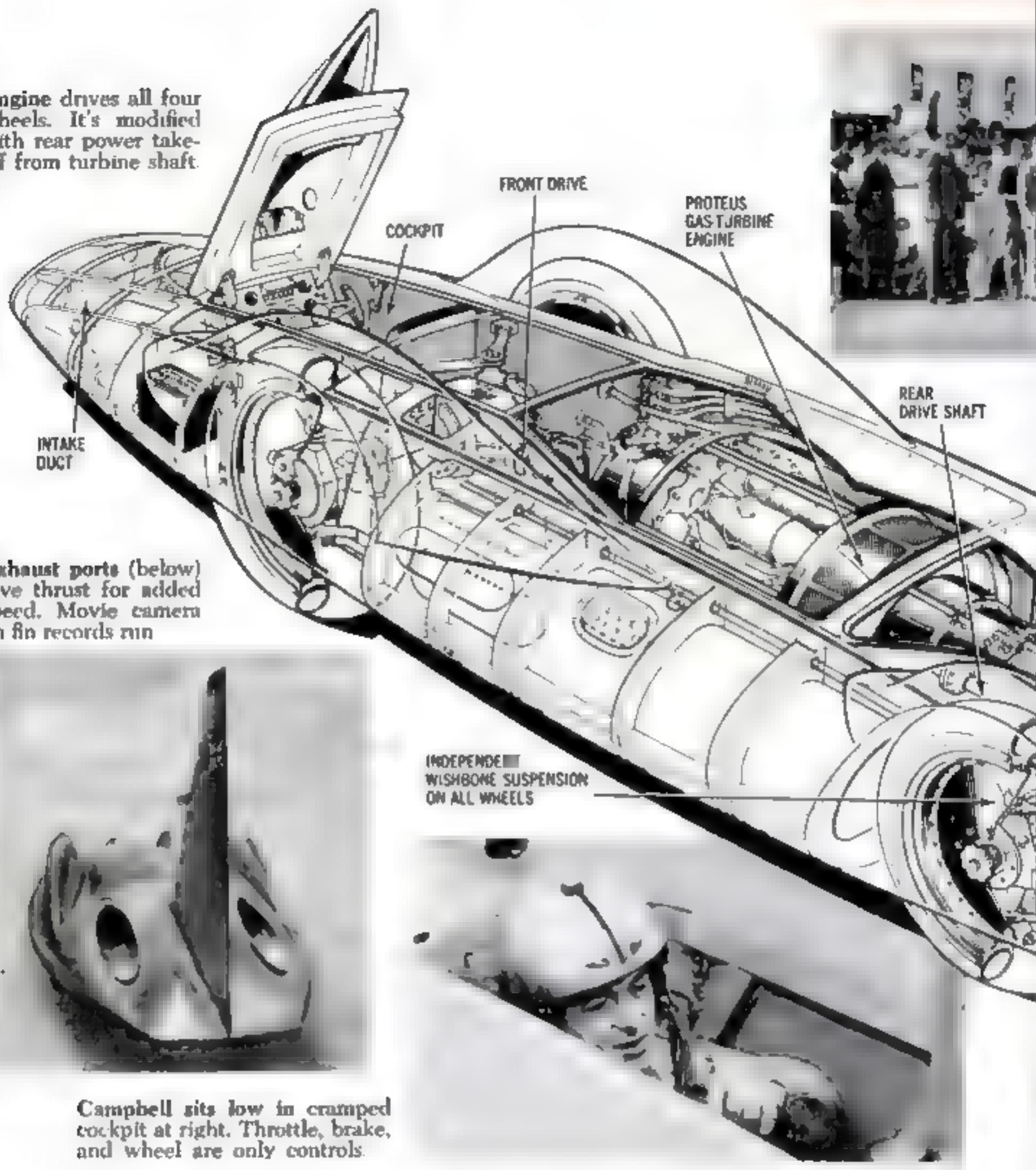


Minicar takes on extra engine to become off-road cross-country vehicle

Individual 52-cu.-in. engines power the front and rear wheels of the Moke, a rough-terrain version of British Motor Corp.'s front-wheel-drive minicars. Each engine is transversely mounted directly over the wheels for added traction. Combined output is 72 hp. The throttle and clutch controls are linked, but separate gear levers permit disengaging the rear drive when it is not needed.

At a demonstration in snowbound England last winter, the Moke showed exceptional climbing ability and versatility as a load carrier, snowplow, and prime mover. Price in England is \$1,330.

Engine drives all four wheels. It's modified with rear power take-off from turbine shaft.



Campbell sits low in cramped cockpit at right. Throttle, brake, and wheel are only controls.

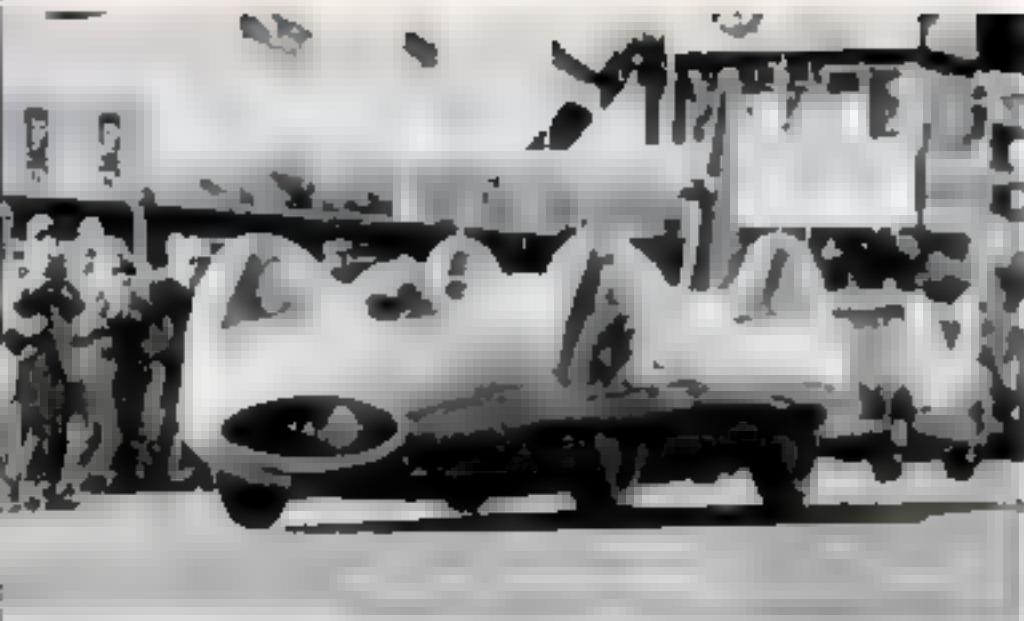
Bluebird makes another bid for

The attack on John Cobb's long-standing 394 m.p.h. land-speed record (still official despite Mickey Thompson's one-way run of 406.6 m.p.h. in 1960) will be renewed this month at Lake Eyre, Australia, by Donald Campbell. The Britisher will pilot a Bluebird rebuilt according to lessons of his crash in 1960 on the Bonneville Salt Flats in Utah.

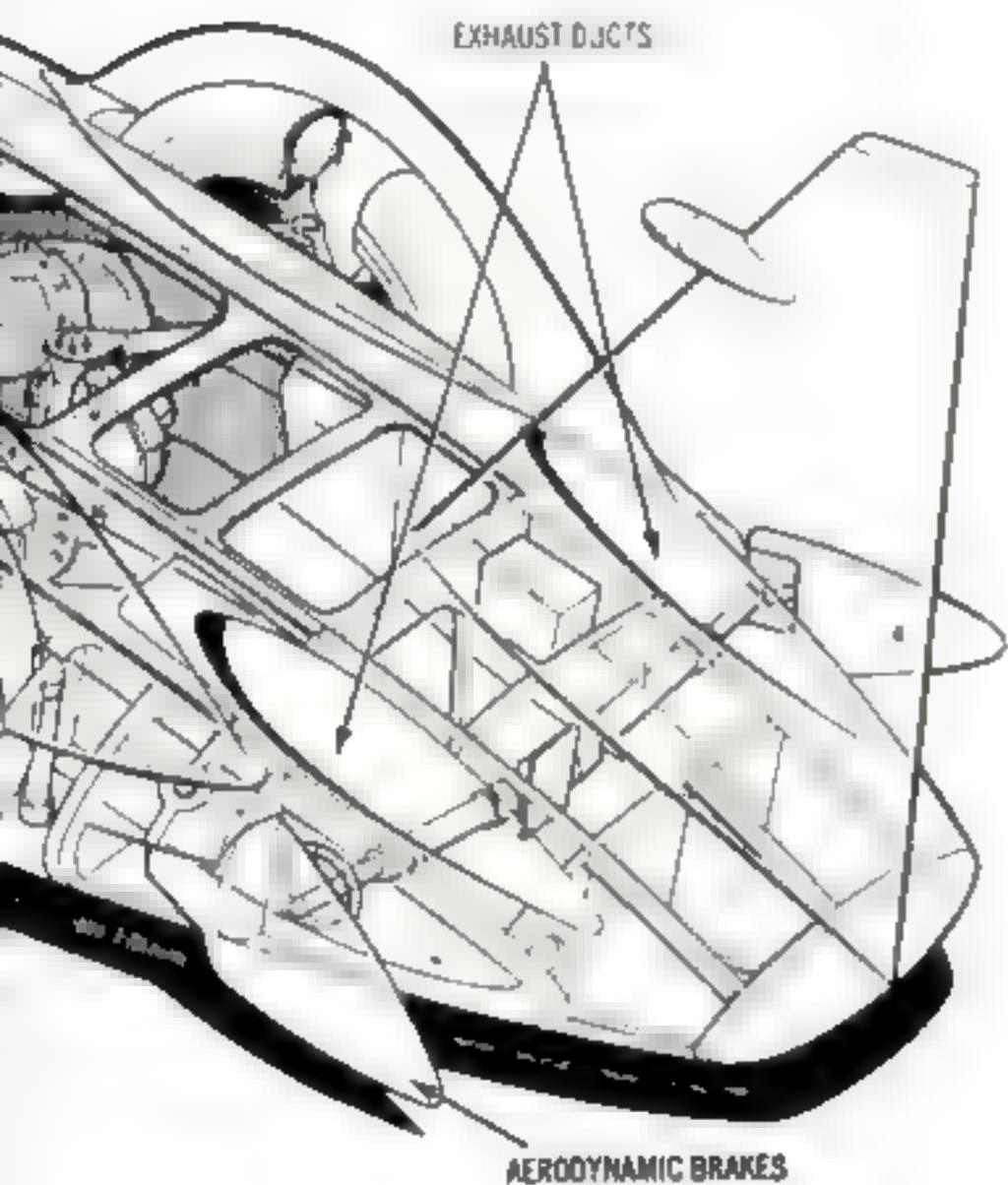
Added this year is a tail fin to improve

stability at high speeds. The fin stands 7 feet 8½ inches above the ground, but is designed to be shrunk section by section, after initial tests, for a compromise between stability and drag. Lockable front and rear differentials also help the Bluebird hold course.

The Bristol Siddeley Proteus turboprop aircraft engine delivers 4,100 hp. at 11,100 r.p.m.—enough, it is hoped, to push the car



Rebuilt Bluebird begins demonstration run at Goodwood race track in England. Shatterproof bubble is fiber-glass and clear plastic.



speed record

to 450 m.p.h. No power-robbing transmission is necessary.

Wheels with 52-inch-diameter tires are sprung on nitrogen in oleopneumatic suspension-shock-absorber units designed for maximum traction. Brakes are twin-caliper disks operated by air and capable of a 60-second stop from 400 m.p.h. Supplementing the disks are flap-type air-resistance brakes on both sides of the tail.



Solid Army punch on the move

Mauler, shown here in an engineering mockup, is the Army's answer to front-line bombing and strafing by enemy jets and harassment by short-range missiles. While on the run, the mobile, self-propelled launcher can fire a dozen radar-guided solid-fuel rockets at a time. The guided-missile carrier was developed by General Dynamics at Pomona, Calif., for the Army Missile Command at Redstone Arsenal.

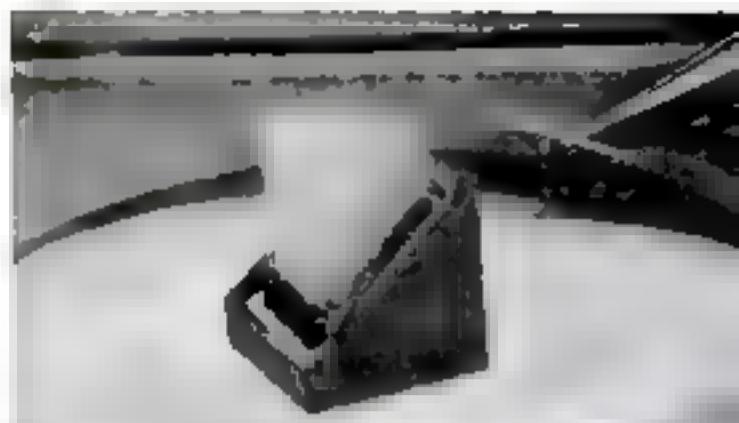


Concrete-and-glass football

With two curved sides coming to a point at the ends, the Phoenix Mutual Life Insurance Building brings something new in architecture to Constitution Plaza in Hartford, Conn. Incorporated in the design are a two-level underground garage for 300 cars and an enclosed street-level park. The building will open in September.



Table-top Sceptron hookup, listening to talk by its demonstrator, lights up indicator (right of center) whenever he says "five"—and ignores every other word. Assembling enough Sceptron units to obey many verbal commands might yield voice-operated phone dials and cash registers, and typewriters that take dictation by directly transcribing spoken words.



Heart of Sceptron is tuft of quartz fibers, like one held in forceps. Fibers vary in length, and different frequencies, blended in an incoming signal, make different ones vibrate.

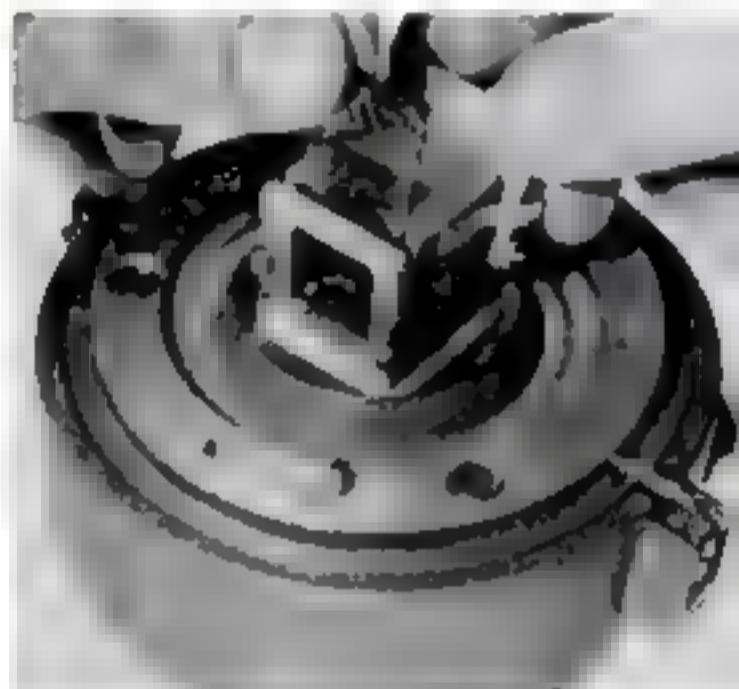


Photo-plate mask, being inserted, is "memory" that recognizes a certain word. Interchangeable masks, each with a different pattern, make Sceptron responsive to various cues.

"Tell It to Sceptron!"

Newest electronic brain recognizes spoken words,
and will carry out your verbal commands

By Alden P. Armagnac

PHONES that dial a spoken number, typewriters that print out whatever you say to them, underwater ears that identify a hostile submarine—these are just a few of the uses foreseen for a new signal-recognition "brain."

In a recent demonstration of its talents, an engineer talked into a microphone connected to a table-top version of the device. The instrument had been set up to respond to the word "five." Whenever he

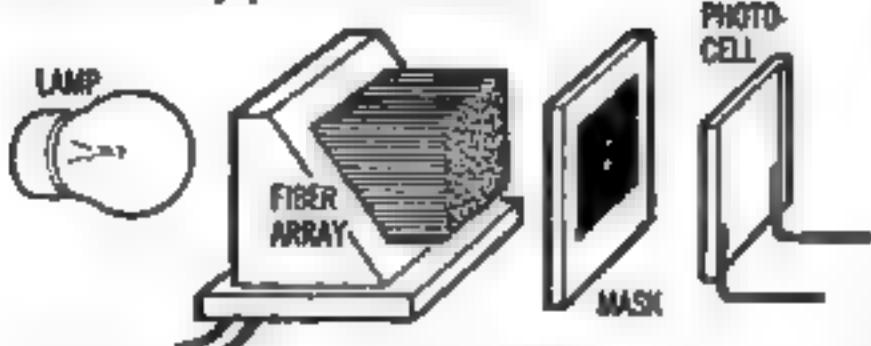
uttered this word, the brain instantly flashed a telltale light. It ignored every other word he said.

As easily, the device can be adapted to recognize any word whatever—or any signal, audible or visible, that can be translated into electrical pulses. A composite "brain," made up of a number of the units, could recognize many spoken commands and respond in appropriately different ways to each one.

Called the Sceptron (for "Spectral comparative pattern recognizer"), the device is

HOW SCEPTRON WORKS

These are key parts of "brain":



Sceptron consists essentially, left to right, of a lamp; a cluster of quartz fibers, through which lamp's rays travel lengthwise, vibrated by an incoming electrical signal; a mask, whose pattern transmits the light emerging from some fibers' tips but not from others'; and a photocell, which responds to light by actuating a signal such as a buzzer or indicator lamp.

A mask, to transmit the particular signal of interest and reject others, is made by these steps:

1 Photo plate is exposed to light from tips of fibers at rest. Resulting negative forms "rejection mask" that blocks light from zero (no) signal.



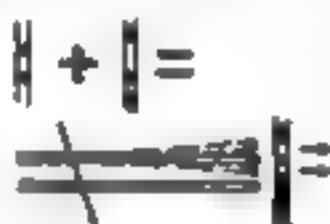
2 While fibers are vibrated by signal to be recognized, second plate is exposed to tips. This negative provides a "rejection mask" that blocks light from wanted (to-be-recognized) signal, and also from a zero signal.



3 Making photo positive from second negative gives "acceptance mask" that transmits light from wanted signal or zero signal.



4 Combining this positive and first negative gives "acceptance mask" passing light of wanted signal—and of no other one.

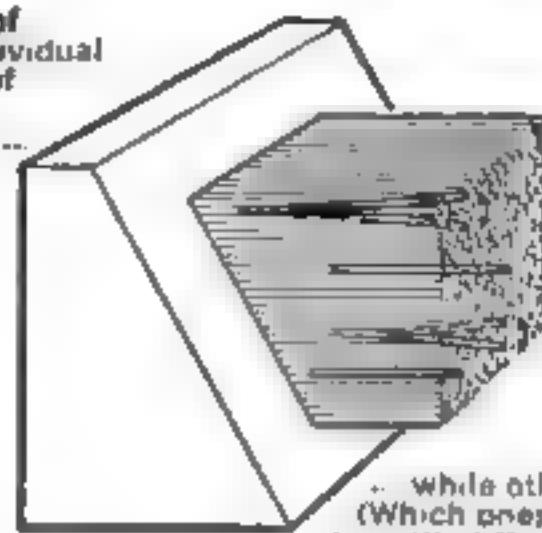


being readied for both civilian and military uses by the Sperry Gyroscope Co., which considers its novel principle an advance as fundamental and versatile as the transistor. Invented by Robert Hawkins, Sceptron combines vibrating optical fibers that analyze sounds or other signals, and a photographic memory cell to recognize them.

Within a Sceptron is a tuft of 700 or more transparent quartz fibers, of varying length, supported at one end like bristles in a shaving brush. An incoming signal jiggles the fibers' mounting, by means of a driver unit such as a loudspeaker coil or a piezoelectric transducer. Some fibers vibrate, others don't, depending on their individual responses to the various frequencies blended in a signal.

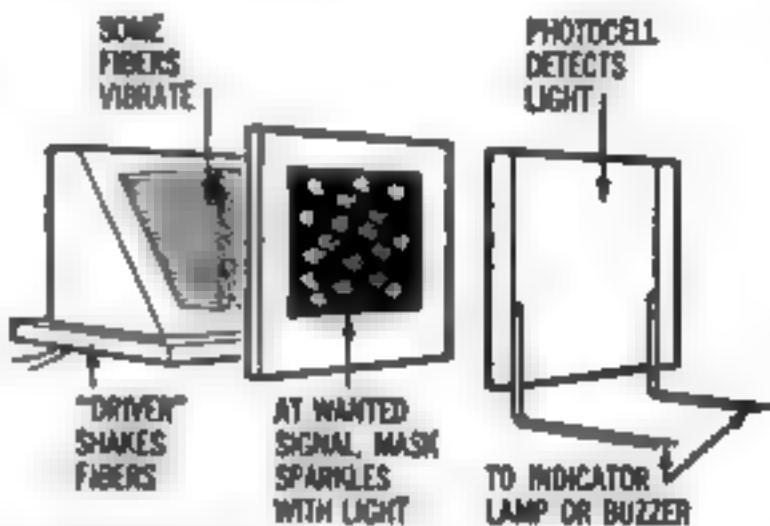
Meanwhile, light from a lamp bulb travels lengthwise through the fibers—and emerges

In response to signal like word "five":



Some of the individual fibers of quartz vibrate...
while others do not.
(Which ones dance varies with different words.)

A Sceptron in action



When the right signal comes along, such as the spoken word "five," Sceptron's mask sparkles with twinkling pinpoints of transmitted light—and its photocell responds by turning on an indicator lamp or buzzer. To all other incoming signals, Sceptron is oblivious; its mask remains dark and its indicator inactive. Singly or grouped, Sceptron units can be adapted to recognize any spoken word, a particular person's voice, the sound of an enemy submarine—or anything else, including pictures as well as sounds, that can be converted into an electrical signal.

from their quivering or motionless tips.

All that need be added to put Sceptron in business is a "memory" mask, which transmits the emerging light only when the fibers are vibrating in a particular pattern—and, beyond the mask, a light-detecting photocell. Accompanying drawings show how the complete device works, and how the mask is made—by the very signal that it's to recognize. Variations in mask-making technique give a mask that recognizes a certain word, whoever speaks it; or a certain person's voice, whatever he says.

In the demonstration model, Sceptron's quartz-fiber array takes up a cubic inch of space, but Sperry has already made a miniaturized version as small as 1/300 of a cubic inch. Thus, it says, it's approaching the point where a composite "brain" as complex as the human brain could be put in a desk-size console.

New ideas from the inventors



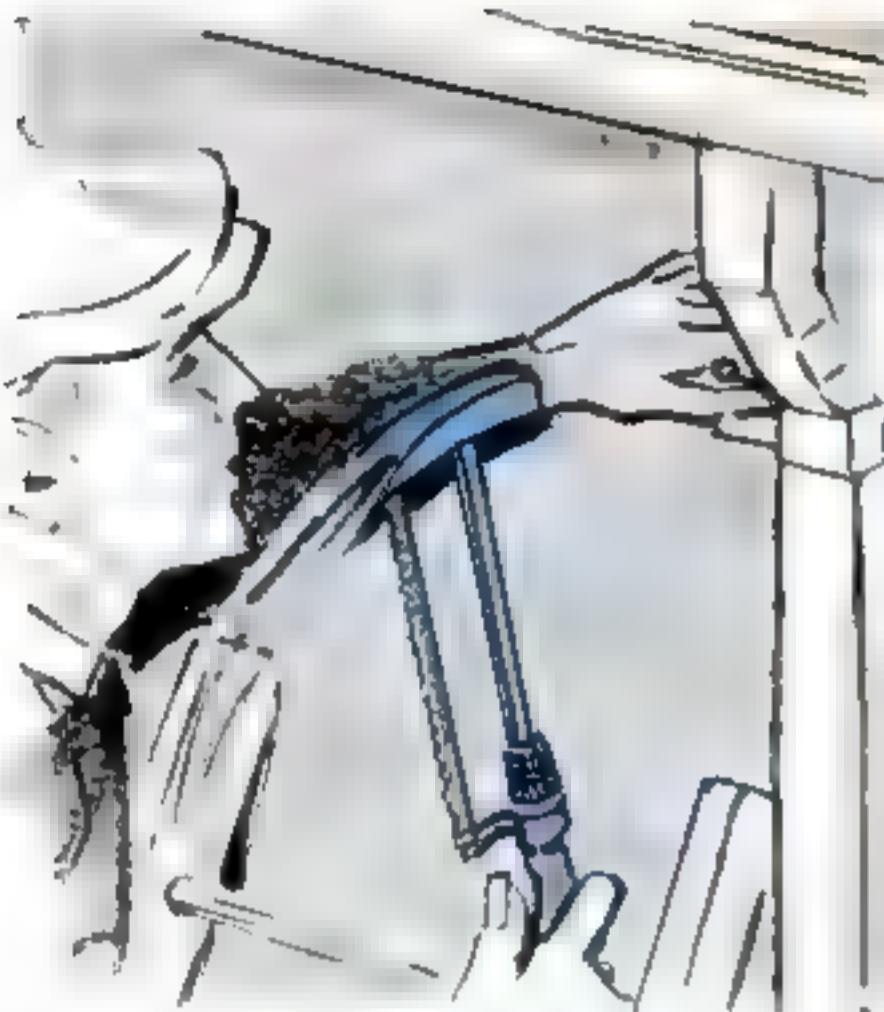
Fold-in wheels carry boat. Lightweight wheels that could be carried in a small boat or canoe might ease lake-to-cabin hauling or lake-to-lake portaging. These recently patented wheels would be hinged to a frame clamped to the gunwales. Thumbscrews would lock them in riding position, release them to swing inboard one on top of the other.



Cap measures powdered coffee. Your instant coffee might be even more instant—as well as more uniform—if you replaced the jar cap with this screw-on dispenser. Pulling a slide would release a fixed amount of coffee into the dispenser through one aperture; pushing the slide would drop it into the cup through an exit aperture.



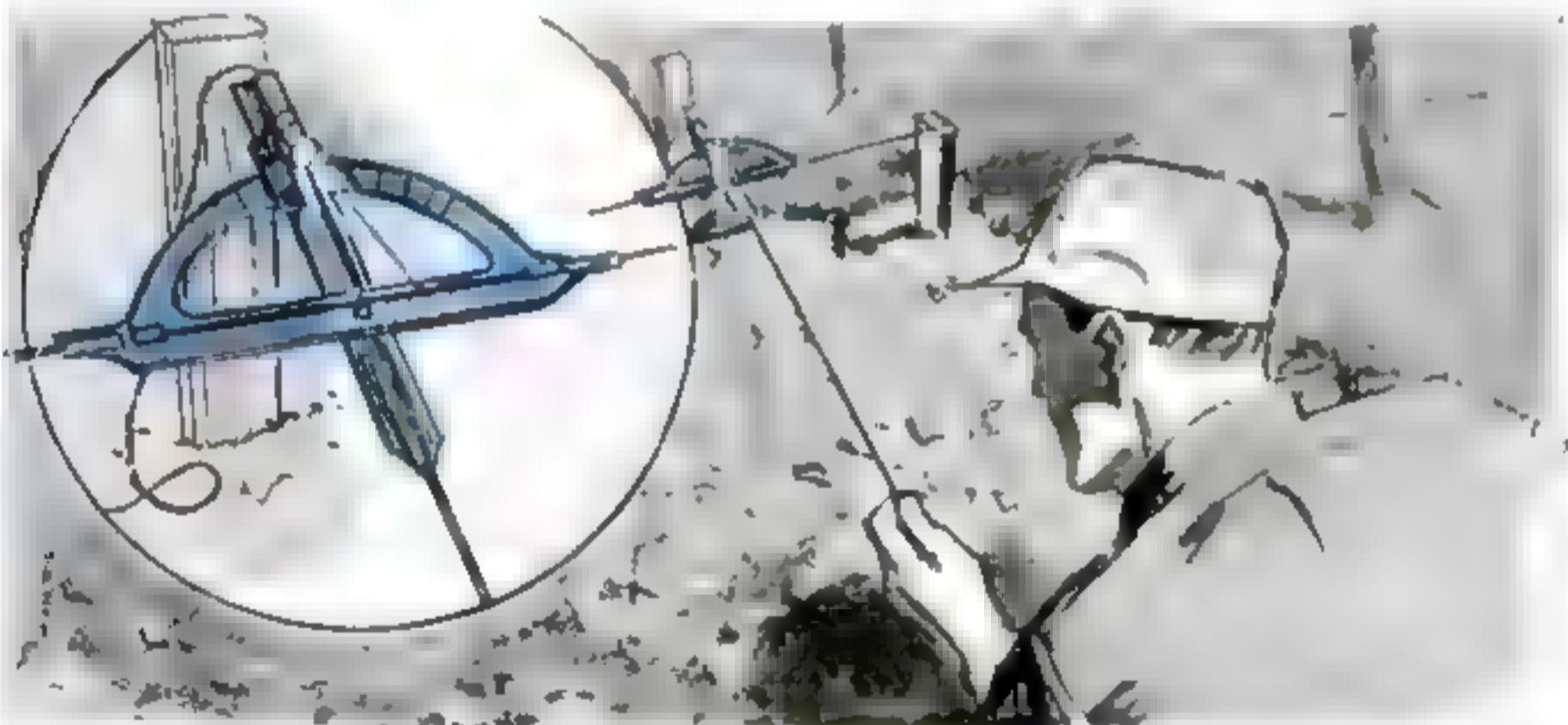
Wiper keeps lights clean. You might see—and be seen—better in bad weather with a system that kept headlights clean. This GM invention would divert a jet from the windshield washer to spray the lenses, and wipe them with a blade whose pivot point would be ratcheted around the lights. The blade would then snap up out of the way.



Kit fits saw to hammer. You might do less interchanging of tools if you had this knockdown, multipurpose kit for handyman jobs. Saw, claw, and hammer would support each other, and any one could be used without changing the setup. Reversing the tool, you could chuck matched drills and screwdrivers in the handle.



Handle inflates umbrella. You'd be prepared for doubtful weather with this collapsible umbrella in your pocket. To use it, you'd pull the pleated, plastic canopy out of its case, slip the case onto a plunger, and work the plunger to pump air between the canopy's seams. Telescoping joints would extend the handle.



Protractor light guides line. One man could sight a construction line easily and accurately with this light-up protractor. He'd set an adjustable contact to any de-

sired angle, then draw out the line attached to a pivoting contact. When the contacts closed, a flashlight would signal that the line angle was just right.

The following patents have been issued on these inventions: Boat wheels—No. 3,035,282 to Herbert A. Bemus, Carlsbad, N. Mex.; Coffee dispenser—No. 3,056,532 to Charles E. Germano, Poughkeepsie, N.Y.; Wiper—No. 3,058,142 to Samuel C. Pollock, Rochester, Mich.; Tool—No. 3,038,177 to Fritz Mächtle, Kornthal, Germany; Umbrella—No. 3,053,266 to Thomas H. Burns, Seattle.

Wash.; Protractor—No. 3,061,931 to Benny J. DiStefano, Detroit.

Copies of patents may be ordered, by number, from the Commissioner of Patents, Washington 25, D.C., at 25 cents each. To write to an inventor, if the address given above is insufficient, address him (by name and patent number) in care of the Commissioner of Patents.

Time Bombs in the Mississippi

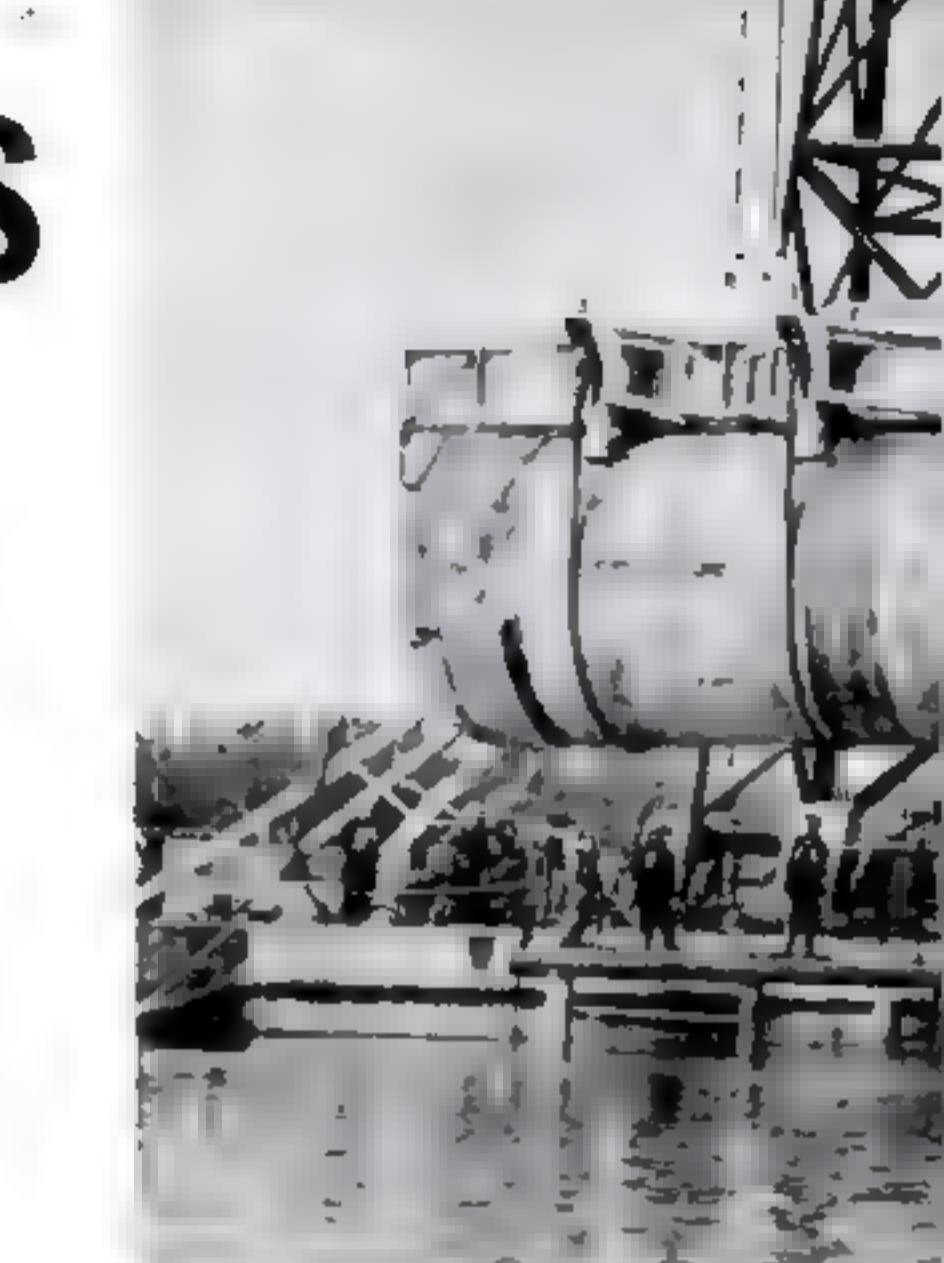
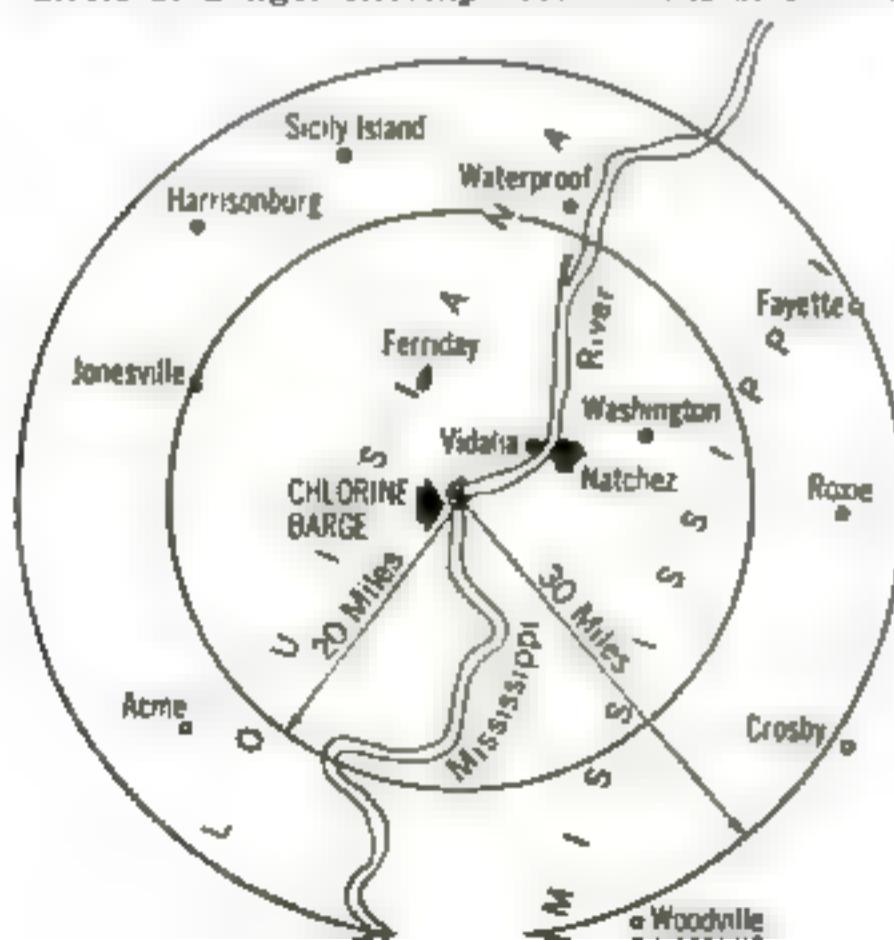
Four tanks of liquid death—chlorine—lay at the river bottom, ready to spew a lethal gas over two states

By E. D. Fales Jr.

TWO states braced for disaster. All ships on the Mississippi had been warned. Six thousand residents had fled Vidalia, La., and Natchez, Miss., where a 15-car escape train waited to gather up hundreds more. At least 40,000 gas masks had been given out, for at any moment a choking yellow cloud might spread like a horrible ghost into the night over Louisiana and nearby Mississippi.

The U.S. Weather Bureau had set up

Circle of danger encompassed dozens of towns.



First of the huge tanks is lifted

six emergency stations to test the slightest shift in wind, on which the safety of 70,000 now might hang.

Armed troops waited along Mississippi roads to snatch wrecked cars away and keep traffic moving if the gas came. Disaster workers flew in. The Red Cross evacuated the sick. Over Louisiana highways came a parade of vans—the disaster fleet of the Louisiana State Police.

In 20 towns, meetings were called. If the gas comes, citizens were told, *move fast and keep moving*.

A circle 60 miles across was declared the danger zone. It reached from Fayette, Miss., west to Acme, La., taking in long stretches of U.S. Highways 61 and 84. On the Mississippi River, ships and barges heading toward Natchez were stopped and gas masks given crews and passengers.

Somewhere at the bottom of the river lay four weird time bombs that together contained more poison gas than was used in any major battle of World War I.

The nightmare had begun at dawn on March 23, 1961. The 3,500-hp. diesel towboat Eastern had been battling upriver behind 16 barges, hugging the eastern



by Bohm and Herman B. A 30-ton strongback rides astride the tank. Valve dome is at right.

shore, working north in quiet backwaters.

Its barges rode four abreast. The left-front one, called Wychem 112, was making a 1,200-mile voyage from Baton Rouge to Charleston, W. Va. It carried a cargo for a large chemical company—four monster green-and-white steel tanks. Each, if stood on end, would tower over a six-story building. Rising from each was a steel dome that protected sensitive safety valves. The domes carried the ominous lettering, CHLORINE.

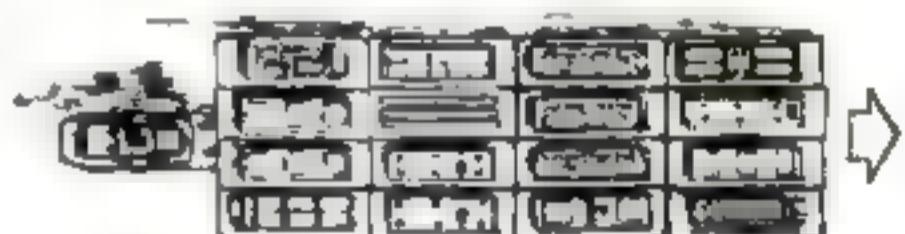
Seven miles south of Natchez, all north-bound ships make the Natchez Island crossing. At 4:47 a.m., in hazy light, the Eastern came to the crossing and headed for the western shore. And at this moment the four front barges smashed headlong into a vicious spring-flood current.

A bow wave built up. Three of the four leading barges rode it out. But from Wychem 112 came staccato sounds like gunfire as the giant wave raced across her deck and crashed into her hold.

The sounds were Wychem's cables parting. Swamped by the wave, the barge poked her bow under the surface, shot down like a submarine—and vanished mysteriously.

The river here, in flood, was 100 feet deep. The Army Engineers patrol boat that sped to the scene, fathometer going, should have had no trouble picking up strong echo signals from such a huge wreck. But no signals came back. And, later, when divers went down, they found no trace of a wreck at all.

No one worried—yet. A newspaper quoted an official as saying that a shipment of



chlorine had sunk, but if any escaped it would merely "purify the muddy Mississippi." This was a remarkable statement in the light of later events.

Liquid chlorine is a pale-yellow fluid. Released from tank pressure, it turns into green-yellow chlorine gas. By coincidence, not many days earlier, a railroad tank car of chlorine had burst in a train wreck near New Roads, La. A green-yellow cloud had scourged the countryside for six miles. Over



Ramseyer

Stern hucked high in the air, the Wychem 112 snapped its cables and nose-dived like a sub.

100 people were taken, choking, to hospitals. A child died. Hundreds of animals were killed. Yet this had been a relatively small shipment, a mere 20,000 pounds. By contrast, there was 2,200,000 pounds of liquid chlorine in the four submerged tanks.

But more than a year passed during which the prosperous Valley towns lived in blissful ignorance. Then last summer someone told the U.S. Public Health Service: Somewhere at the bottom of the river was enough chlorine to fill a whole train of tank cars. Since all wrecks rust, it was only a matter of time before it would escape. There was also the danger that a ship might ram the wreck, for the river was dropping 80 feet to a 40-foot summer depth. Or a falling anchor might smash the tanks. Or weakened safety valves might blow.

Quickly, the nation's "disaster central"—the office of Emergency Planning in Washington—swung into action. On September 7, a decision was made. Since the Army Corps of Engineers keeps rivers navigable, it would be their job. Orders went to the Vicksburg district: "Find those tanks. Use any means to get them out—fast." The district chief in Vicksburg, Col. Warren S. Everett, read his orders and whistled. If rust had set in, even minutes might count. But where were the tanks?

A remarkable search began. Three days later, a Navy submarine-hunter plane, cruising low near Natchez Island, began getting strikes on its electronic sub-hunting gear. Yet this was an area that had been carefully searched before. The answer lay in the shifting sands of the river bottom. The barge had become a restless ghost, moving with the sands.

A crew was sent to drill the river bottom. Water-jet probes, which would not burst the tanks, were used. The next afternoon, 65 feet below the surface and 14 feet deep in sand, a probe hit a hard object. The Wychem, after a year and a half, had been found.

Col. Everett moved fast. On September 30, his salvage contracts were let. At 4 a.m.

the next day a \$10 million commando salvage fleet was highballing toward the scene from a Gulf Coast port 600 miles away. It included two towering hammerhead derrick-barges, an ocean tug, two floating crew-hotels, and 20 other craft. At the same time, rolling east from California came trucks bringing 16 "wind machines"—gasoline-powered fans used in fighting Western forest fires. Should the gas escape, engineers would try to roll it back behind a wall of wind to give the 130 crewmen a chance to get off their ships.

A call went out for divers. Courage and skill were needed: Underwater cutting torches, burning at 5,000-degrees F., would have to be held steadily within an inch and a half of the steel tanks. This would be like holding a lighted match beneath a fuse, for steel, in chlorine, lights up and burns at 400 degrees.

The salvage contracts went to two Gulf Coast engineering outfits: Triple-C Boats, Inc., and Brown & Root, marine operators.

In all the excitement, few citizens had noticed three dusty pickup trucks from Texas that plowed along the levee near Natchez and discharged their load: a pile of diving suits, some underwater cutting torches, and eight solemn-faced men—divers.

They came from an outfit called J & J.

Waiting to make a new descent, chief diver Joe Carroll (right) chats with author on deck of the Bolin. Hard hats and life jackets were compulsory throughout the operation.



of Pasadena, Tex. The two Js stand for Joe and John: Joe Carroll, president and chief diver, and John Galletti, vice-president.

Lights glittered all over the salvage fleet when Carroll, Galletti, and six hand-picked divers saw it. A curtain of sound hung in the night: the whine of compressors, the roar of wind-machines tuning up, the clatter of hammers.

For days before they dared enter the river, Carroll and his team pored over blueprints of the Wychem, memorizing every rivet. Meanwhile, a diving station was set up on the Bolin, one of the two derrick barges.

When Carroll dived on October 14, he was appalled by the blackness of the river. It was like diving into strong coffee. He couldn't see his hand before his helmet, or even the little round window itself. He dropped cautiously, letting himself down a hand line. He wore no diving shoes, only soft galoshes. He didn't want to kick holes in rusty metal.

A diver lives by his lifeline—and his tender. Carroll's tender, a little man in a red steel hat, happened to be another Joe Carroll: his father. As Joe Jr. descended, his father cautiously fed out lifeline-air pipe, steel safety wire, and phone line all wrapped in one.

Underwater, Joe Jr. let himself drop slowly. He was 20 feet down when he heard the propellers of a big barge train, similar to the one to which the Wychem had belonged, fighting its way up the other side of the river. Then a surge of water swept past him, swinging him away from the hand rope. Though the barges were a quarter-mile away, the underwater currents they set up were trying to tear him away from his hand line.

Carroll hung on hard, waiting for the currents to subside, then continued on down. He was to have this experience many times, whenever a large ship or barge train passed. Now, letting himself down, he was suddenly stopped at 40 feet. His feet had hit something soft.

He groped cautiously and felt a small mound of sand. Wishing desperately that he could see, he thought of calling for floodlights but decided they'd be useless.

In the darkness, he had three fears: He might kick a hole in a rusted tank; he might dislodge heavy wreckage that could smash a tank; or he might disturb the sensitive

spring-loaded safety valves on top of each tank, set to blow off under certain emergencies. The valves were shielded inside the protective steel domes. But if they were damaged or had become seriously rusted, they might now be frail as paper. He lay prone to spread his weight and began digging carefully.

Minutes later Carroll's voice reached those on deck. "I'm on the dome of a tank and the damned safety hatch is wide open!" He was right over the naked valves. If they popped off now, he'd be instantly caught in a geyser of yellow chlorine.

Carroll backed away cautiously, coming to rest on a sand drift that he knew must cover a tank. Clammy forces began pulling at his feet. He moved to escape and a moment later his helmet rang against a hard object. He'd floated into a grotesquely-twisted steel handrail reaching up as though the Wychem were trying to climb out of its sandy grave.

The bottom of the Mississippi River is never still. It flows slowly, like a moving sidewalk—toward the sea. The curious force clutching at Carroll's feet was the effect of shifting sands. It was these that had buried the Wychem so quickly. If he made a misstep they might bury him, too.

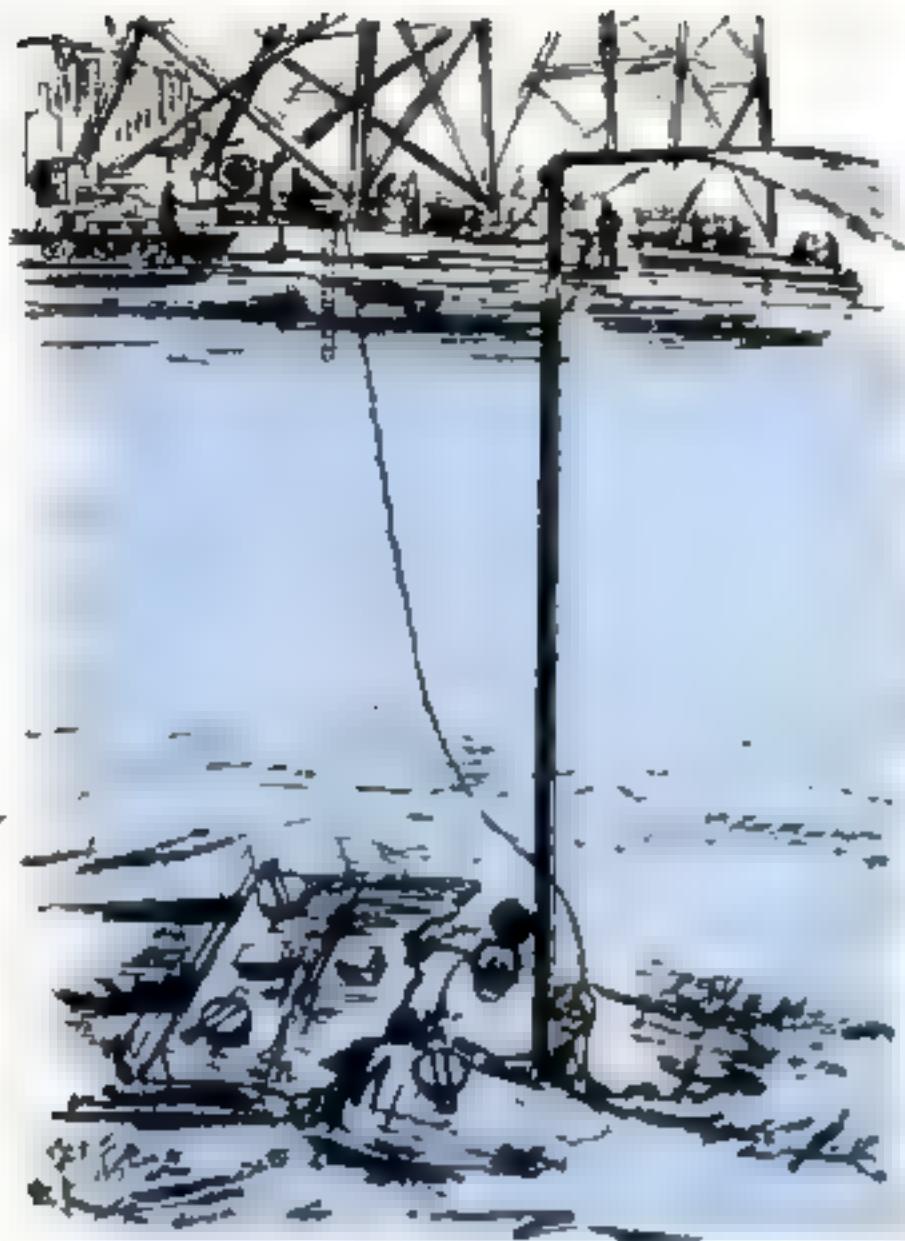
For days, two Army dredges had been doing their best to uncover the wreck, sucking away mountains of loose sand. But since they had not dared drop their clumsy "suction snouts" near the tanks, they had dug a vast crater around it. This crater now was 800 feet wide, and the Wychem rose at its center.

Carroll phoned his discoveries to the deck. Still blind, he now found that by shutting his eyes he could get a better sense of feel and direction. After that, he always worked with his eyes shut.

For two hours he explored, and what his fingers "saw" appalled him. It had been



He wouldn't quit in spite of danger. 'Wee Willie' Brown comes up after a dive.



Bracing a shoulder against the airlift pipe, John Galletti grabbed it with both hands and began to siphon sand and rocks. Little by little, the four huge tanks were unearthed.

an impact wreck. The Wychem had rammed the bottom with enough force to bend itself in half and hurl its 100-foot stern half, along with two tanks, upward until they had tried to fold over the forward half. Then the stern had fallen back.

Toward noon Carroll went topside. "It's one hellish mess," he told his team. "Before we can go for the tanks, we've got to airlift."

An airlift is an angry pipe with the kick of a mule. Get between it and a wall and it will smash your ribs. This one was a 10-inch-diameter, 85-foot-long steel suction pipe.

Night had fallen when the airlift was ready, and John Galletti went down into the river to receive it. He grabbed it in a bear hug and guided it down between the tanks. He drove his shoulder against it and called for power.

The mule began to kick. With a roar, the airlift went to work. On one side of the pipe a high-pressure water jet blasted the sand between his feet, loosening it. On the other, a screaming air jet, turned upward into the bottom of the airlift, created a

mighty siphon. Galletti heard sand and stones booming up in the big pipe; the airlift was beginning its work.

Other divers relieved him: Herb Atwood, Norman Knudsen, Jim Bush, Don Hackin. Then Galletti took over again. Toward midnight, those on deck heard a cry: "Cut!" Galletti's left foot had been pulled into the suction pipe. Someone cut the power. He withdrew his foot and went on dredging. More and more, the tanks were being exposed. Yet the shifting sand kept trying to cover them up. Once diver Tom Hynson used the water jet to hose off the tank tops. It was like using a garden hose under water.

For three days and nights the airlifting went on. On the 19th, Carroll went down to size up the situation.

The No. 1 tank on the port forward side, to be tackled first, was tipped, and slowly creeping toward a sharp steel edge of the barge. The No. 2 tank hung ominously above No. 1. The after tanks, 3 and 4, were in better shape. But all had snapped some of their steel tie-downs, the powerful five-inch straps that anchored them to the barge. And if enough tie-downs snapped unexpectedly the tanks might roll.

Falling wreckage was a hazard. The tank walls were only 1½ inches thick, and tests had shown that even a small hole would grow by chemical action. Liquid chlorine, spurting out, would become a gas, bubble to the surface, and hang low over the river. Even a mild seven-mile-an-hour breeze could blow it into Natchez in an hour.

But the great danger was the electric torches. They can cut through steel as though it were butter. The flick of a flame against a tank could mean disaster.

Carroll's best torch man was a big Texan named Will Brown. "Wee Willie" had one weakness: The greater the danger, the more he hated to quit.

This was the man Carroll chose to start the surgery. His assignment was to burn away tangled railings and pipes, then cut the loading deck—a large steel platform—into sections for lifting.

On October 19, Brown went down with his pistol-like torch. Eyes shut, standing on the No. 1 tank, he found a torn railing, pushed the torch against it and called: "Make it hot!"

On the Bomin, someone closed a switch, throwing 400 amperes into the torch. Brown pulled the trigger and waited for the daz-

zling flame that, he expected, would help him see.

He heard a sizzling sound. But no light came. His fingers grew hot; the torch was blazing not two feet from his eyes, and he couldn't see it. He thought: "Now I do need eyeballs in my fingers."

Almost immediately he made another discovery: The flame refused to bite the steel. Barge and tanks had been painted with tough epoxy-resin paint. After 18 months it was still protecting the metal: He had to burn it for a full 15 seconds before the flame would touch steel. Even so, he often had to chisel or file the paint away.

To cut the supporting beams, it was necessary to crawl under the deck. Brown had just begun a cut there when the explosion came.

They heard it up on the Bolin. The loud-speaker squawked wildly and thunder shook the deck. Task Force Chief Ira Boswell and Salvage Chief W. B. Nelson heard it in disbelief. Men reached for gas masks. Then there was silence, and from the depths, a dark, bubbling swirl appeared.

The silence was broken by the urgent chatter of an outboard motor. Coming fast was a 21-foot surveillance boat, Corky, with engineer Curtis Love at the helm. Love yanked the throttle open and raced the Corky directly into the swirl, his free hand spraying the air with gas-detecting fluid from an atomizer.

If gas were spewing from the river, the fluid—ammonium hydroxide—would turn white, and Love would push the panic button. If he sounded a siren, all hands would abandon. The task force command would broadcast: "MAYDAY MAYDAY MAYDAY FLASH MAJOR ESCAPE OF GAS. ABANDONING." A headlong rush for shore would begin. And as the news spread, 70,000 civilians would rush to cars, buses, and evacuation trains.

As Love reached the swirl, many eyes watched. Three times he squeezed the atomizer. Each time the spray hung briefly and remained clear. No chlorine—yet.

But what had happened below?

Wee Willie Brown's cutting torch was a type fed by oxygen and hydrogen, and at times both gases escape unburned. When Brown went under Wychem's deck, the gases were trapped in an explosive mixture. Working blind, he could not see the gathering bubble, or red-hot bits of metal from his torch.

The blast came with no warning. There



Chalking out a diagram of the wreck is easier over a cup of hot coffee. Carroll and the other divers often worked 12-hour shifts and stayed down as long as two hours at a time.

was a sudden roar. Brown's head rang, the live torch was torn from his hands, and he felt himself hurled through the water. Then he went numb all over.

He came to and heard Joe Carroll on the phone. Carroll was coming down. Suddenly Brown remembered his torch, humming with 400 amperes. He shouted topside: "Make it cold. Make it cold!" Someone cut the power. Then Brown, angry at being tossed around, found his torch and roared, "Hell, I'm all right. Make it hot!" He went to work again.

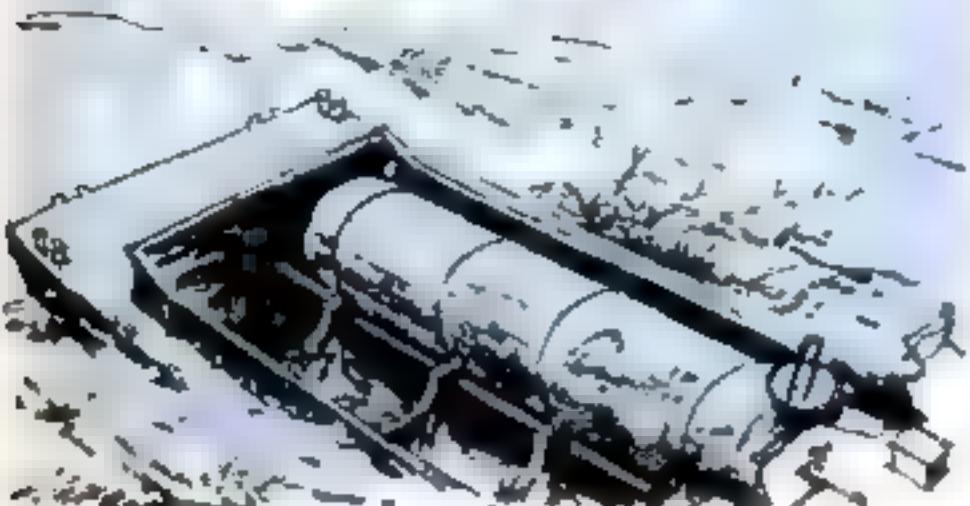
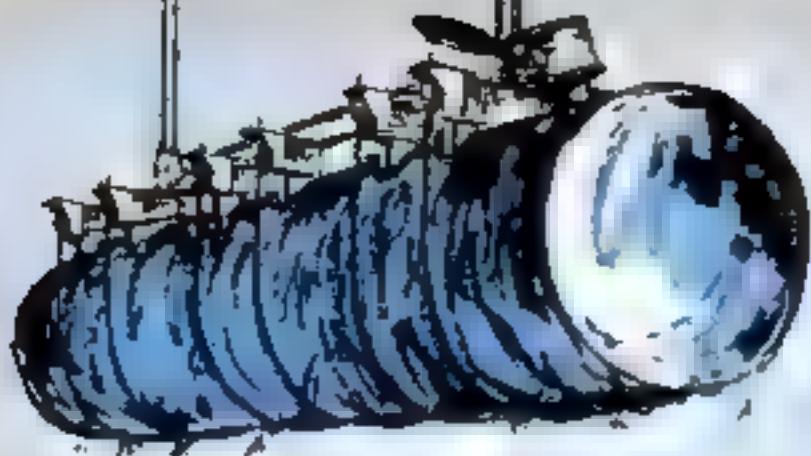
Diver Don Hackin got it next: A smashing explosion like a hand grenade sent him up, bleeding from the nose. After that Carroll went down again.

Hydrogen explosions do happen, but why were these repeating? Fingering his way, Carroll found the trouble: Beams under the deck had trapped gases in several pockets. There was only one thing to do: drain them all.

He called for a torch, crawled out on deck, and began burning holes. Minutes later an explosion hurled him away and stunned him. He'd found the first pocket. He rested, waited for his numb arms to come alive, and then cut again, only to be hit by another blast.

"He worked for an hour," says engineer Ed Kyle. "He was half dead when we brought him up, but he'd bored more holes than a woodpecker." There were no explosions after that.

From October 20 to 22 there were many minor problems, each calmly met and solved. Col. Everett stayed close by in his



Strongback, a 30-ton strait jacket lashed to the tank, was lifted gingerly. Critical moment came when tank "readjusted" itself in its cables from slanting position to horizontal.

patrol boat. But he never interfered, and thereby won the gratitude of engineers and divers. Once, diver Hackin got blown to the surface feet first by a blast of air. Another time, Wee Willie's diving dress ripped and filled. He was hauled up and dumped upside down to drain. His worried mates then saw him grinning at them, upside down, through his window.

Repeatedly the divers crept along the big chlorine tanks, feeling the clammy sides until they found the five-inch-wide tie-down straps. They burned these, a mere inch or two from the tank walls, until they twanged

apart. Sometimes they shoved small asbestos sheets between straps and the tank for safety.

All the loose wreckage was lifted by the night of the 22nd, and the No. 1 tank was ready for its "strait jacket"—a monster steel claw called a strongback. This was 60 feet long and weighed 30 tons. On October 23 it was gingerly lowered astride the tank and the divers lashed the big chlorine-bearing egg to it with 12 sling cables. The derricks wouldn't chance lifting the tank, lest it break in the middle. Instead, they would lift the strongback. This, in turn, would lift the tank, which now lay shakily in its clutches.

At midnight the strongback was ready. Early on the 24th a big impact wrench was lowered to give the sling-cable turnbuckles a last tightening. Then the divers came up. It was now up to the derricks. The lift would have to be silky smooth, so—in this diesel age—the job was given to steam.

Lift day, the 24th, had dawned clear and fearful. To avoid confusion, firemen and police ashore were ordered not to sound sirens for any emergency—but gas. Children in 40 schools went through drills.

At the emergency weather station on the levee, one small problem arose. A screech owl from a nearby wood had developed an interest in the whirling wind cups. It kept flying out to sit on the weather vane, and upset the readings. Weathermen kept running out to chase the owl so they could flash the correct readings by radio. At sunup, the breeze was from the north, good for Natchez but ominous for scattered communities southward. During the day it might shift.

The great danger now was that the No. 1 tank would be dropped. It could be lashed to the strongback only in the tilted position it had assumed in the wreck. During the lift, it would have to be leveled; and this readjustment would throw tremendous strain on the sling cables.

There was also a weight hazard. Under

[Continued on page 214]

Massive 20-part lower block of the Herman B derrick is brought down slowly to pick up one of the special 2½-inch hoisting cables before the strongback is lowered. The Bolin's block can be seen at far right in picture.

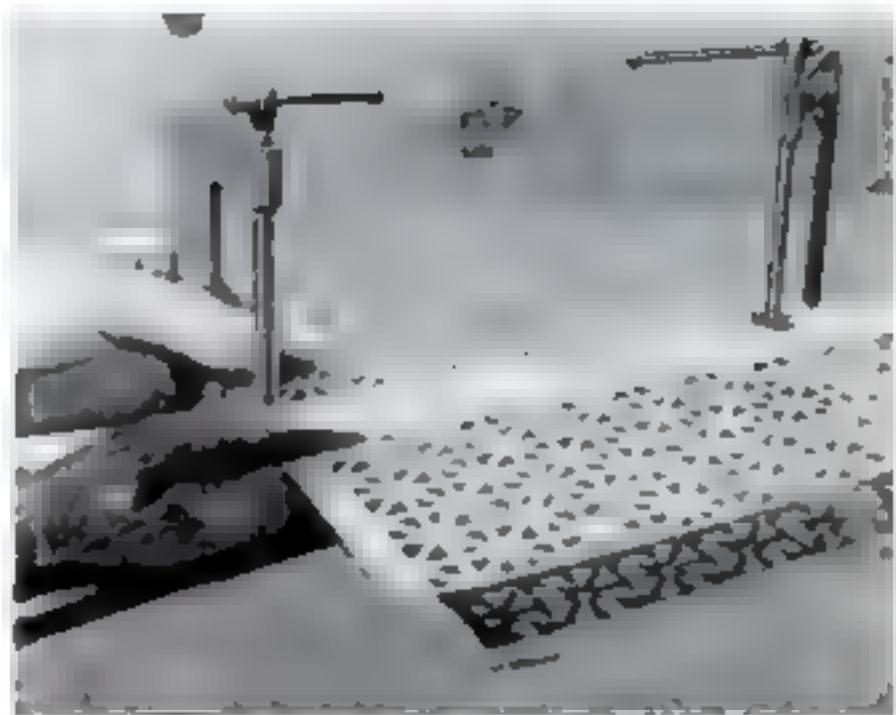




Cord coiling for small appliances

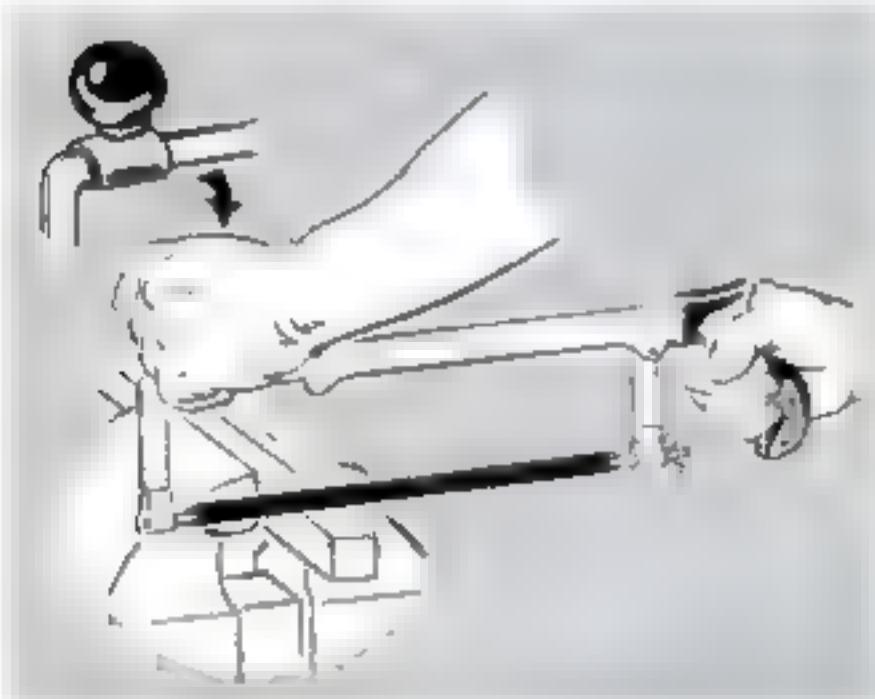
Here's an easy way to coil a cord from a shaver or other small appliance without fuss or fumbling. Hold the shaver in the crook of the thumb (as shown above) while your extended fingers act as hooks on which to wind the cord tightly. As you withdraw your fingers, pull the plug through. Easy as pie—and fine for appliances that can't be left permanently plugged into an outlet.

—Jack Kenison, Tacoma, Wash.



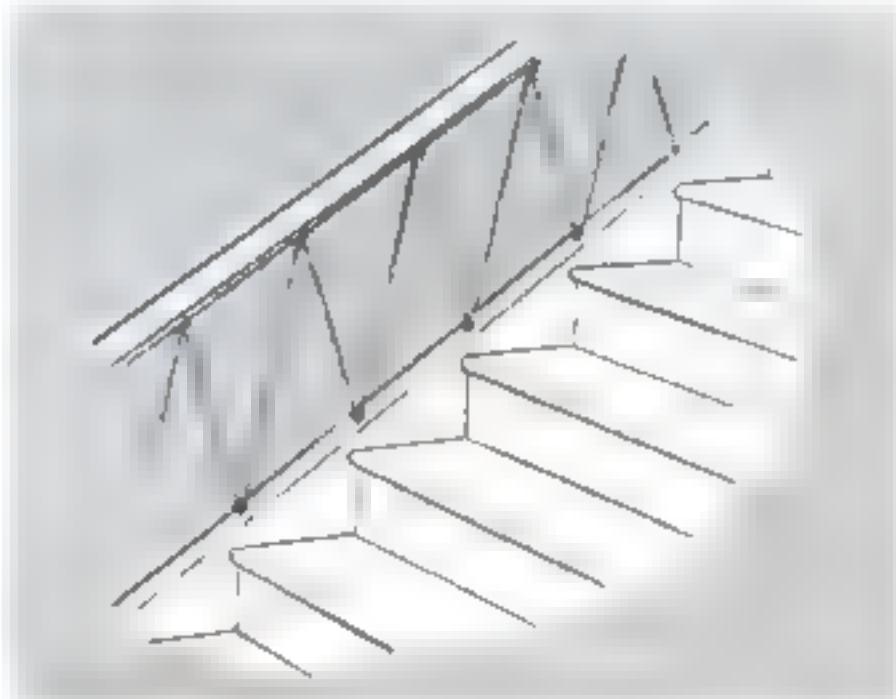
Smooth way to cut without scribing

A pencil or scribed line on workshop sheet aluminum is not easily seen when cutting. To lick the problem, I clamp each end of a yardstick to the metal and use it as a guide for my cutting snips. By looking at the inch marks, I can tell where to stop cutting. A small piece of work is shown, but of course the yardstick is long enough for use with a large sheet of aluminum.—Ken Murray, Colon, Mich.



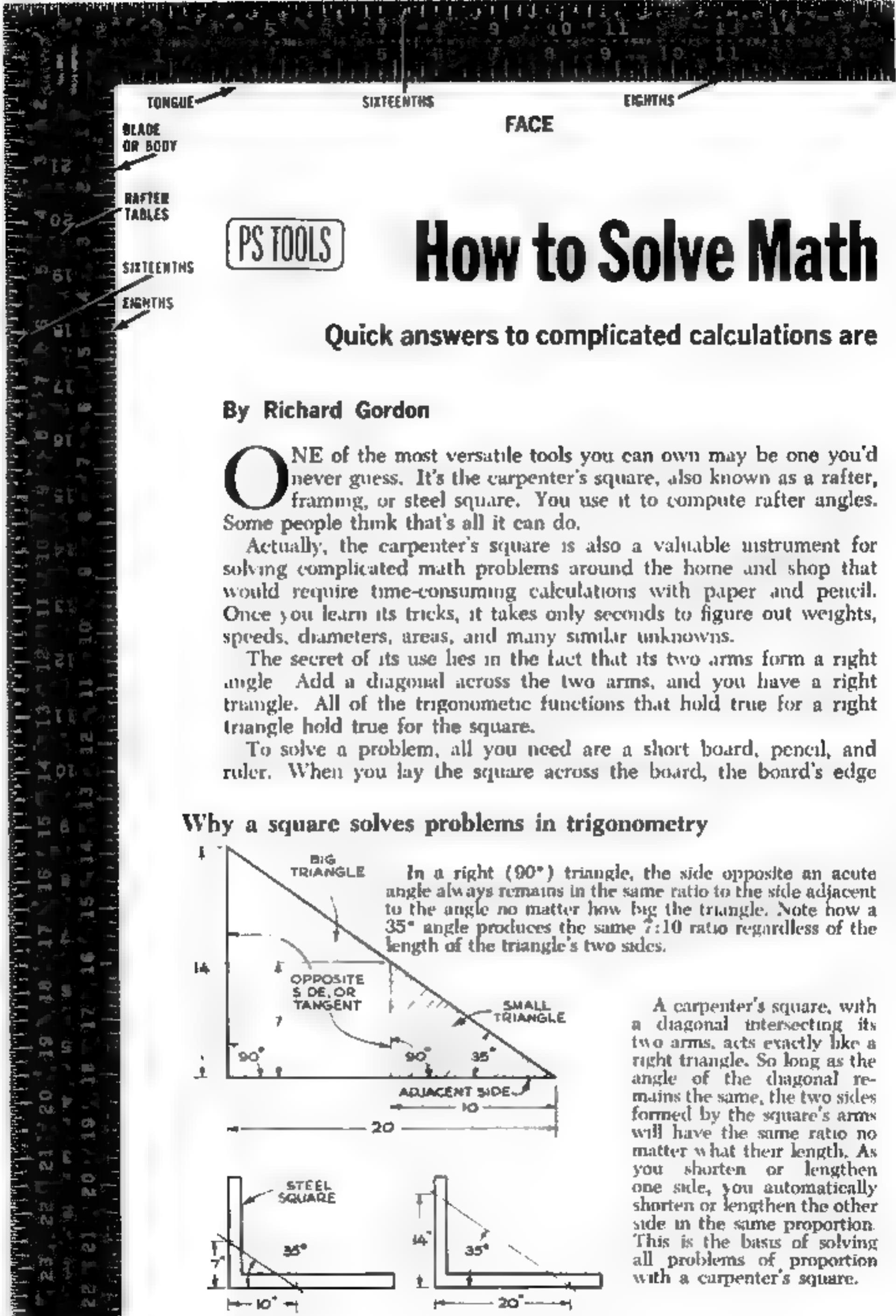
Adding a knob to a hacksaw

Mounting an auto steering-wheel control on a hacksaw provides a better grip when two hands are needed for quick or difficult cuts. The knob also prevents slipping on the backstroke—and injury to your other hand—which can happen when you hold only one end of the saw frame.—M. Peacock, King of Prussia, Pa.



Clothesline makes stairway safer

A little work and some inexpensive materials made my open stairway safe. After securing the handrail at a convenient height, I installed screw-eyes along its underside and on the edge of the stairs. Then I zigzagged a plastic clothesline through the screw-eyes and anchored it with a knot.—Mrs. M. Krucker, Davenport, Iowa.



How to Solve Math

Quick answers to complicated calculations are

By Richard Gordon

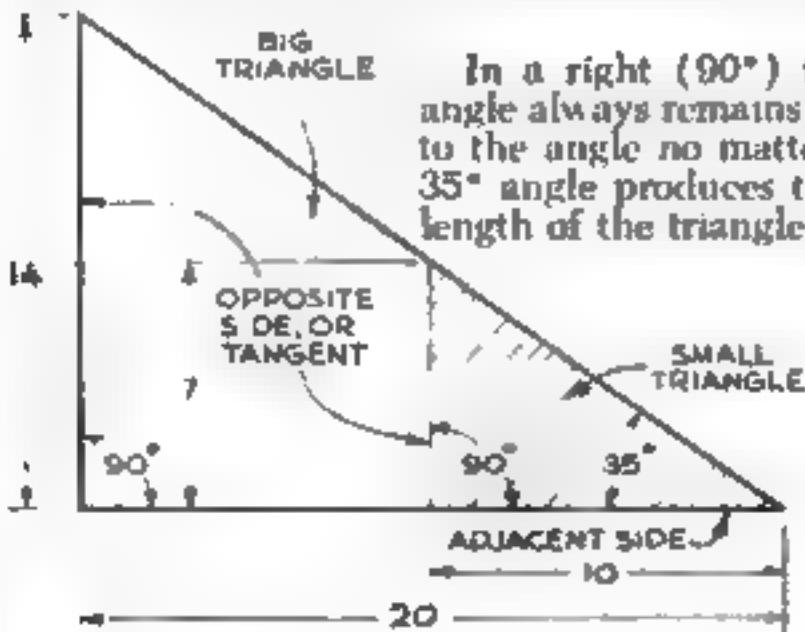
ONE of the most versatile tools you can own may be one you'd never guess. It's the carpenter's square, also known as a rafter, framing, or steel square. You use it to compute rafter angles. Some people think that's all it can do.

Actually, the carpenter's square is also a valuable instrument for solving complicated math problems around the home and shop that would require time-consuming calculations with paper and pencil. Once you learn its tricks, it takes only seconds to figure out weights, speeds, diameters, areas, and many similar unknowns.

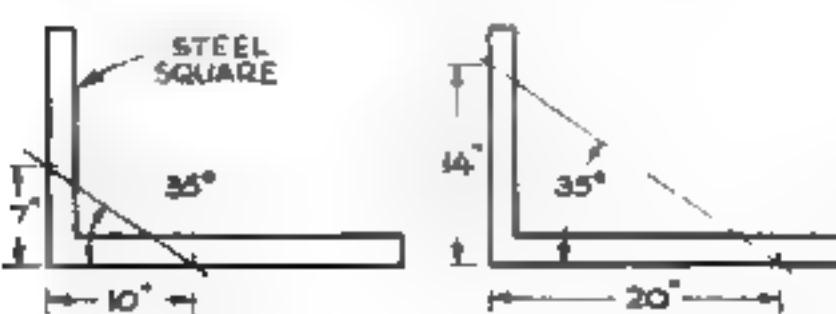
The secret of its use lies in the fact that its two arms form a right angle. Add a diagonal across the two arms, and you have a right triangle. All of the trigonometric functions that hold true for a right triangle hold true for the square.

To solve a problem, all you need are a short board, pencil, and ruler. When you lay the square across the board, the board's edge

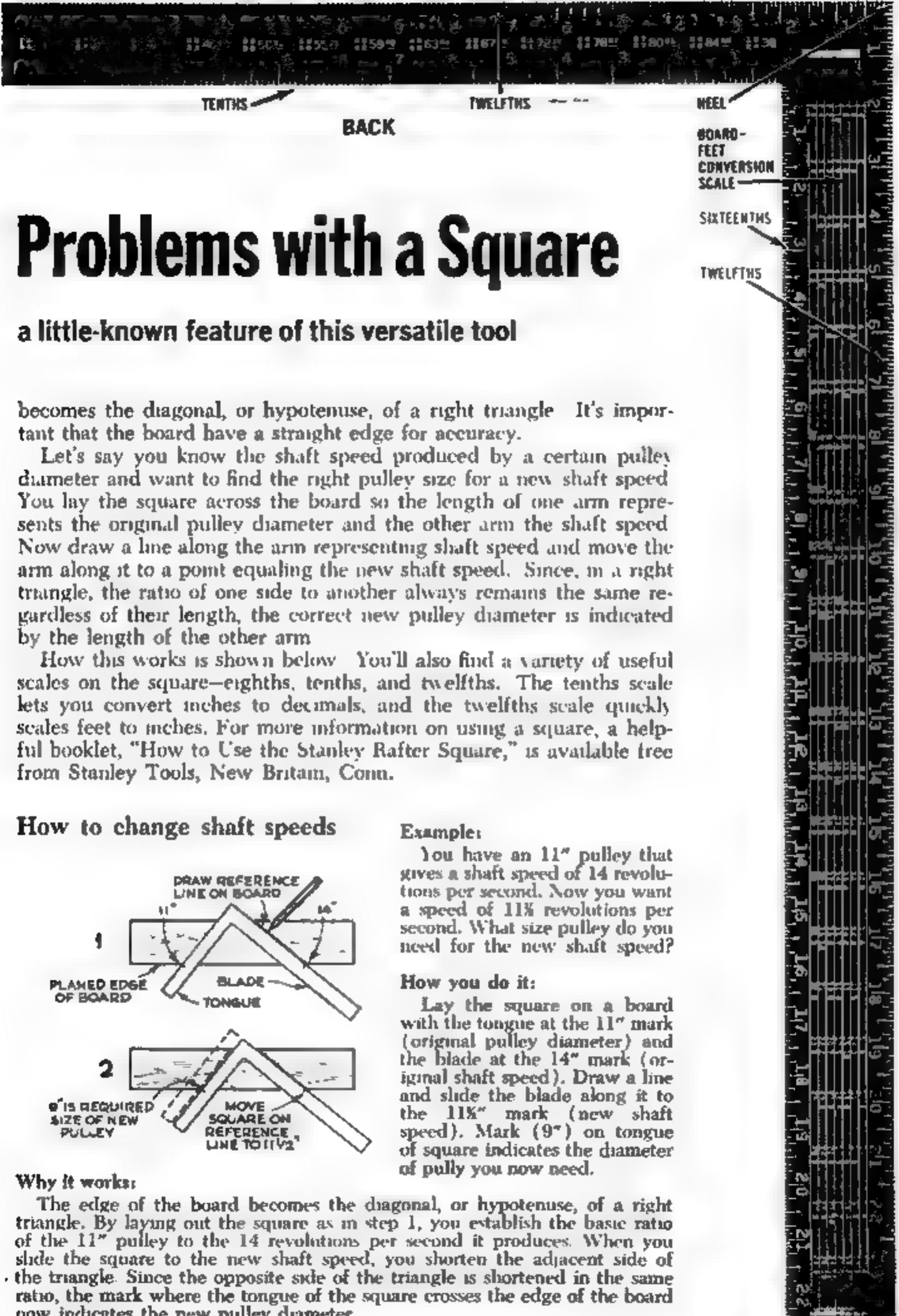
Why a square solves problems in trigonometry



In a right (90°) triangle, the side opposite an acute angle always remains in the same ratio to the side adjacent to the angle no matter how big the triangle. Note how a 35° angle produces the same $7:10$ ratio regardless of the length of the triangle's two sides.



A carpenter's square, with a diagonal intersecting its two arms, acts exactly like a right triangle. So long as the angle of the diagonal remains the same, the two sides formed by the square's arms will have the same ratio no matter what their length. As you shorten or lengthen one side, you automatically shorten or lengthen the other side in the same proportion. This is the basis of solving all problems of proportion with a carpenter's square.



Problems with a Square

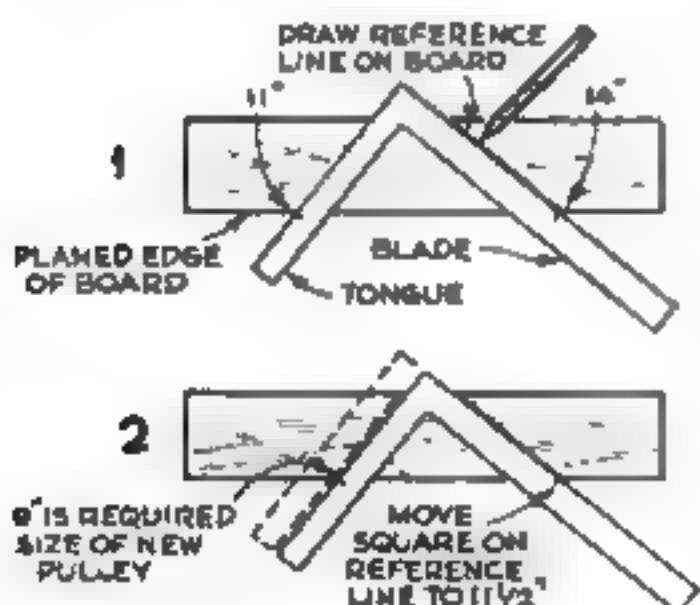
a little-known feature of this versatile tool

becomes the diagonal, or hypotenuse, of a right triangle. It's important that the board have a straight edge for accuracy.

Let's say you know the shaft speed produced by a certain pulley diameter and want to find the right pulley size for a new shaft speed. You lay the square across the board so the length of one arm represents the original pulley diameter and the other arm the shaft speed. Now draw a line along the arm representing shaft speed and move the arm along it to a point equaling the new shaft speed. Since, in a right triangle, the ratio of one side to another always remains the same regardless of their length, the correct new pulley diameter is indicated by the length of the other arm.

How this works is shown below. You'll also find a variety of useful scales on the square—eighths, tenths, and twelfths. The tenths scale lets you convert inches to decimals, and the twelfths scale quickly scales feet to inches. For more information on using a square, a helpful booklet, "How to Use the Stanley Rafter Square," is available free from Stanley Tools, New Britain, Conn.

How to change shaft speeds



Example:

You have an 11" pulley that gives a shaft speed of 14 revolutions per second. Now you want a speed of 11½ revolutions per second. What size pulley do you need for the new shaft speed?

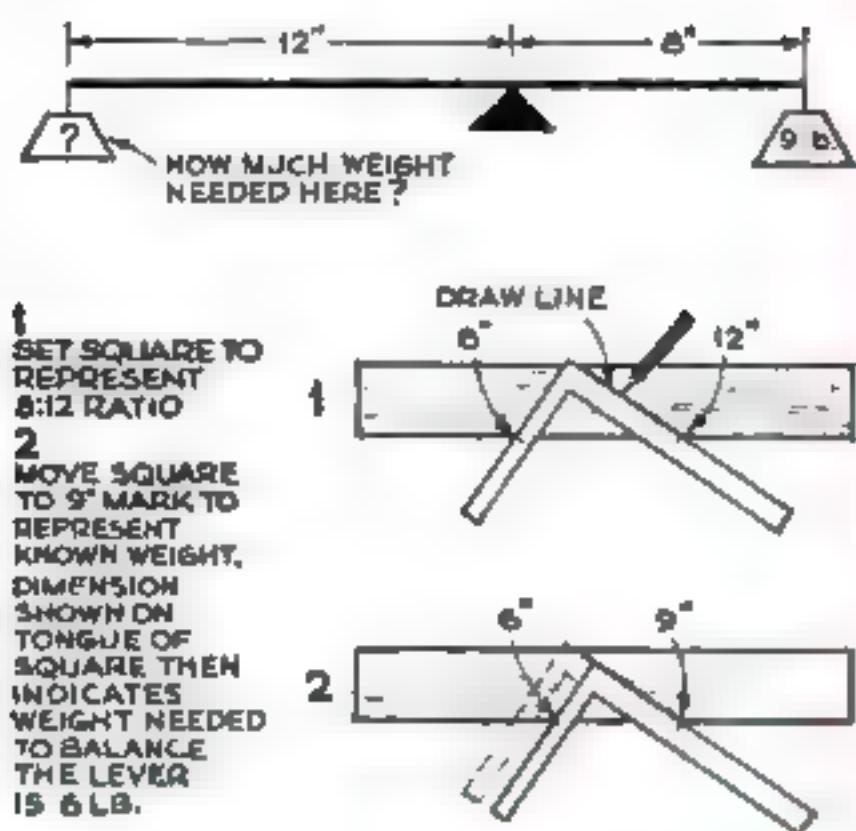
How you do it:

Lay the square on a board with the tongue at the 11" mark (original pulley diameter) and the blade at the 14" mark (original shaft speed). Draw a line and slide the blade along it to the 11½" mark (new shaft speed). Mark (9") on tongue of square indicates the diameter of pulley you now need.

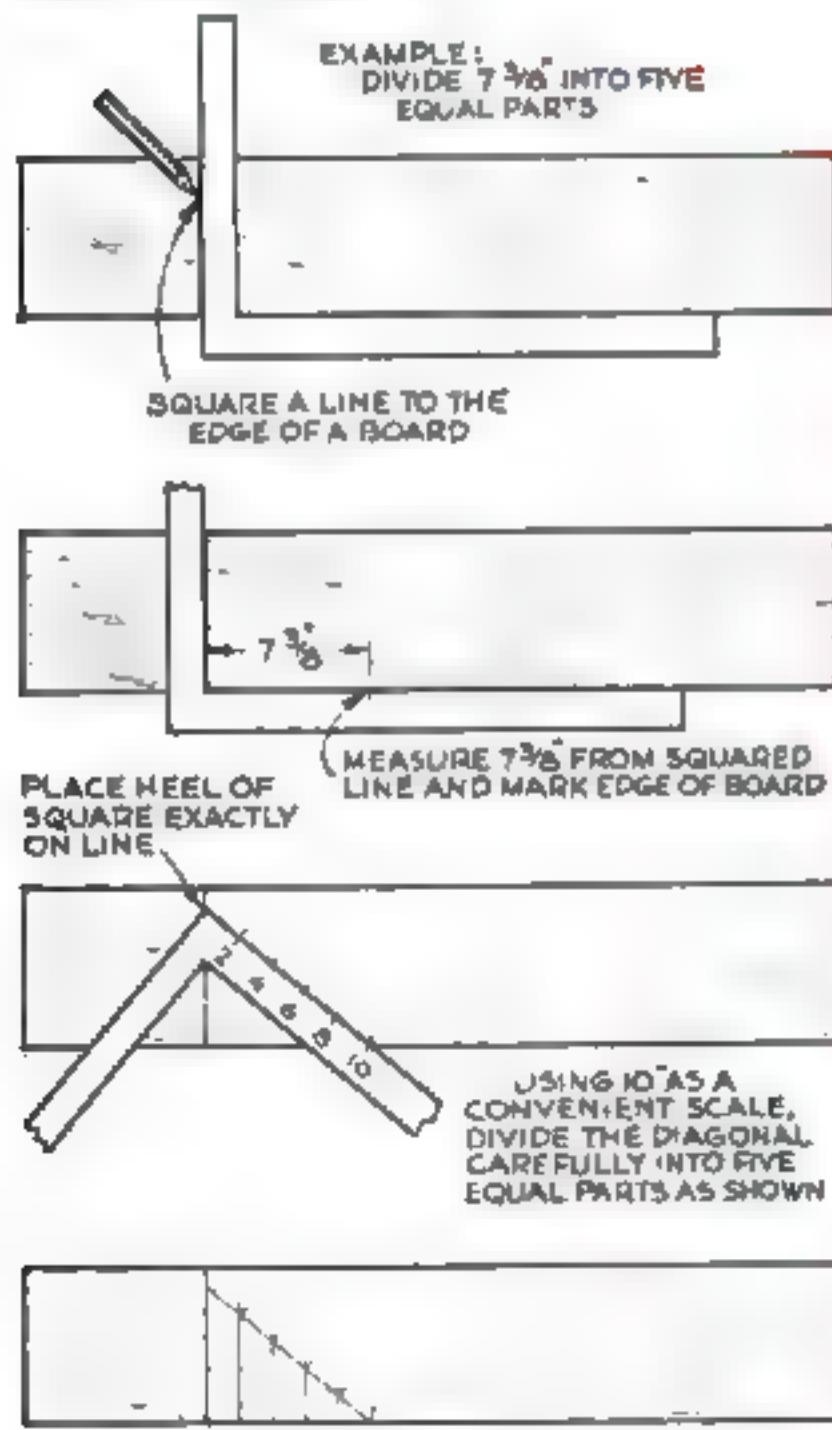
Why it works:

The edge of the board becomes the diagonal, or hypotenuse, of a right triangle. By laying out the square as in step 1, you establish the basic ratio of the 11" pulley to the 14 revolutions per second it produces. When you slide the square to the new shaft speed, you shorten the adjacent side of the triangle. Since the opposite side of the triangle is shortened in the same ratio, the mark where the tongue of the square crosses the edge of the board now indicates the new pulley diameter.

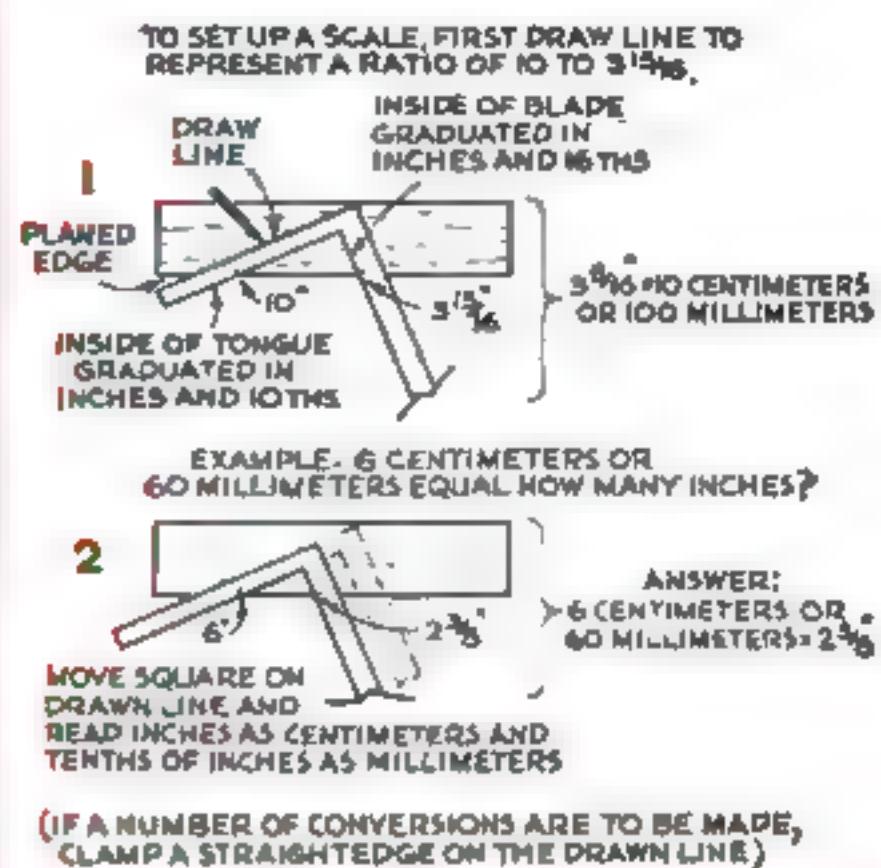
How to balance a lever



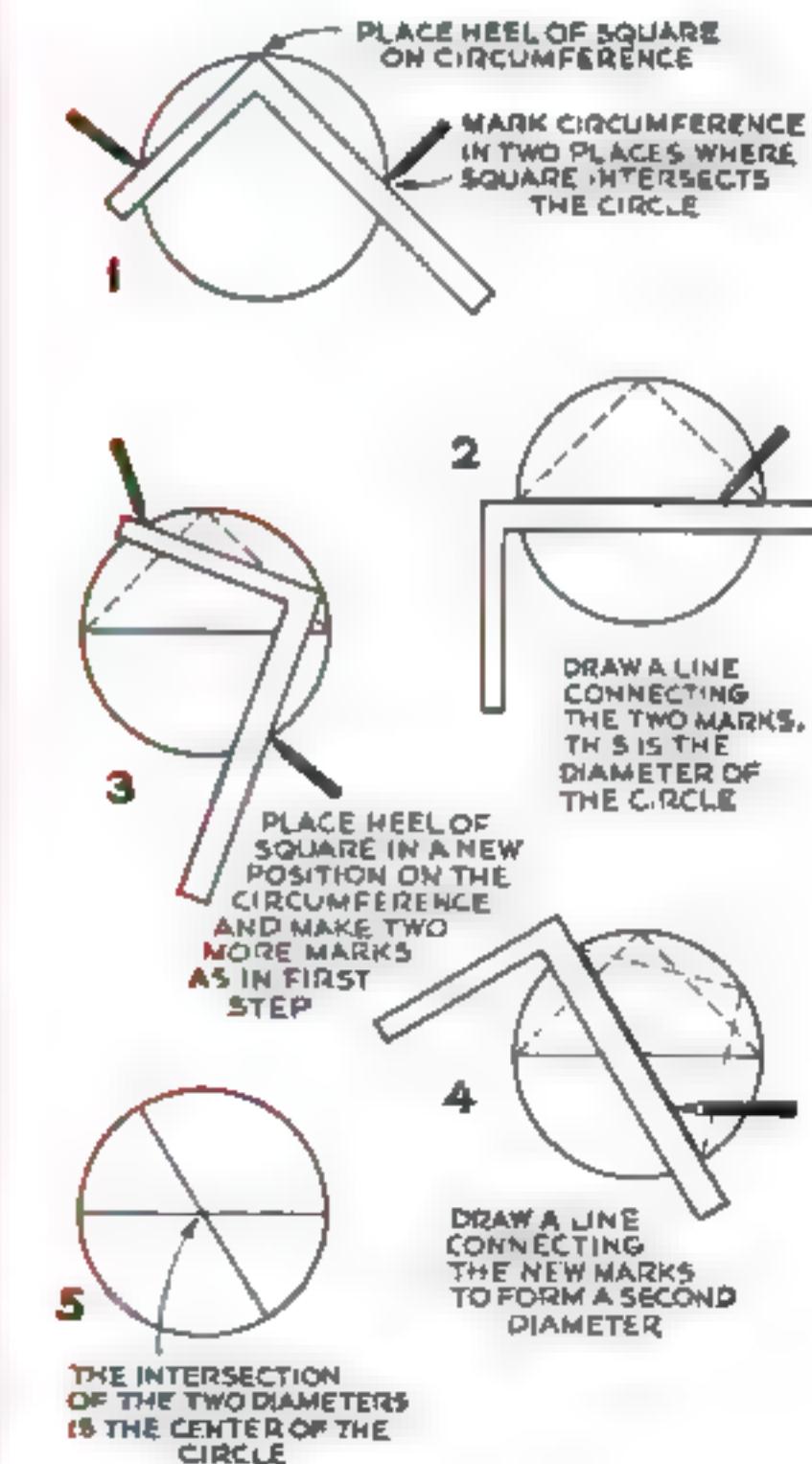
How to divide a line into equal parts



How to convert centimeters or millimeters to inches



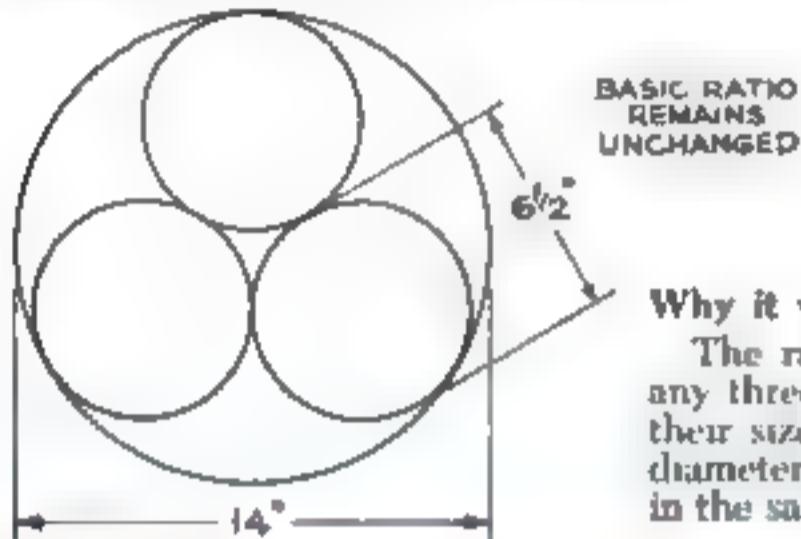
How to find the center of a circle



How to inscribe three small circles inside a large circle

How you do it:

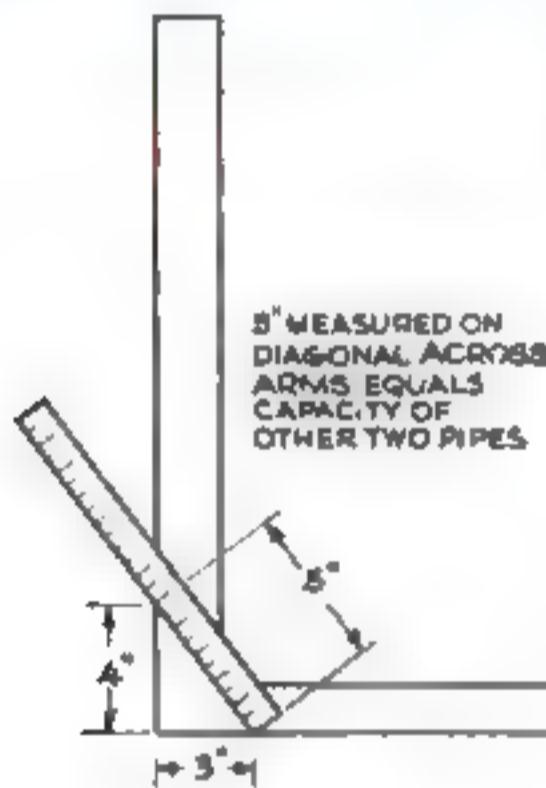
Set the square at the $6\frac{1}{2}^{\circ}$ and 14° marks as shown (right). Draw a line and slide blade to the diameter of the large circle that you want to use. The diameter of the small circles is then indicated on the tongue of the square



Why it works:

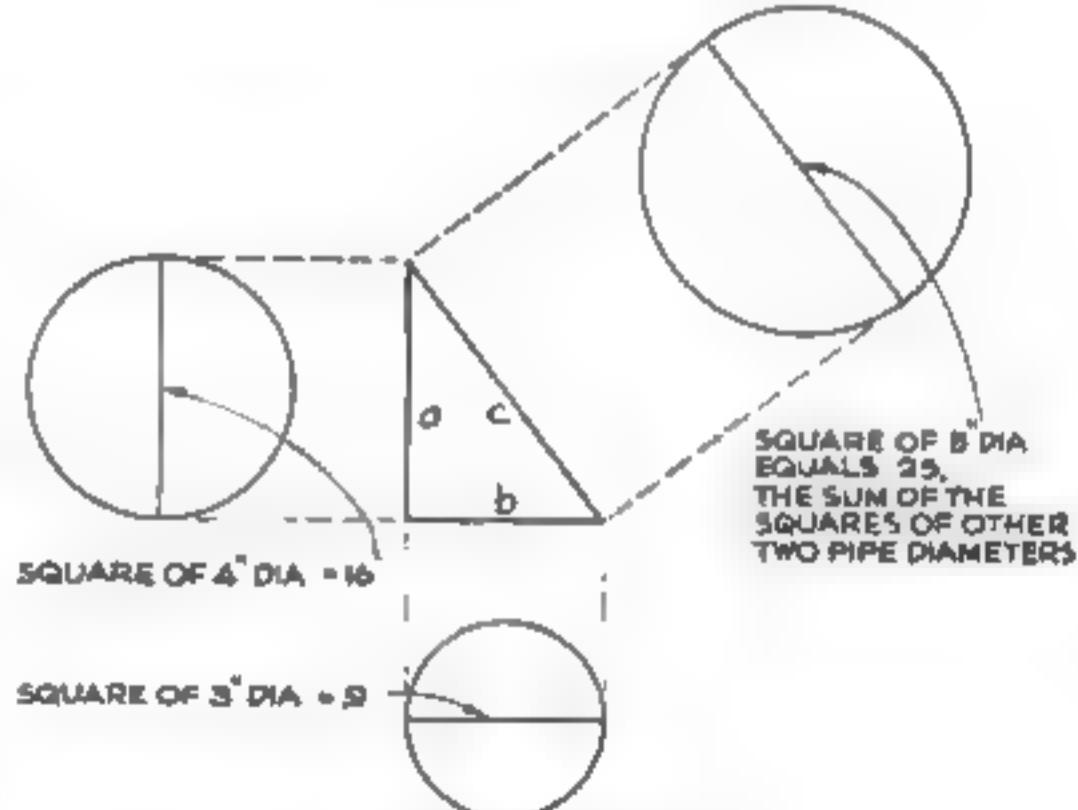
The ratio of $6\frac{1}{2}:14$ that you set up in step 1 holds true for any three small circles enclosed in a larger one, no matter what their size. Sliding the blade of the square to any desired large diameter automatically causes the correct small diameter, always in the same ratio, to show up on the tongue.

How to find one pipe that equals two



How you do it:

Locate the inside diameter of one pipe on the blade of the square and the id of the other pipe on the tongue, then measure the diagonal between the two points. The result—here 5° —is the diameter of a pipe equal in capacity to the other two.



Why it works:

This trick is based on the ancient Pythagorean theorem: In a right triangle, the square of the hypotenuse equals the sum of the squares of the other two sides. The diagonal across the square is the hypotenuse of a right triangle. Its square— 25 —equals the sum of the squares of the two small pipe diameters. The square root of the diagonal— 5 —is thus the geometric equivalent of a pipe diameter totaling the other two pipes. This is proved arithmetically at right. ■ ■

Proof by area of circles ($\text{area} = \pi r^2$):

$$\begin{array}{ll} \text{Area of } 3^{\circ}\text{-dia. pipe:} & 1.5 \times 1.5 \times 3.1416 = 7.069 \\ \text{Area of } 4^{\circ}\text{-dia. pipe} & 2 \times 2 \times 3.1416 = 12.566 \end{array}$$

$$\text{Total area: } 19.635$$

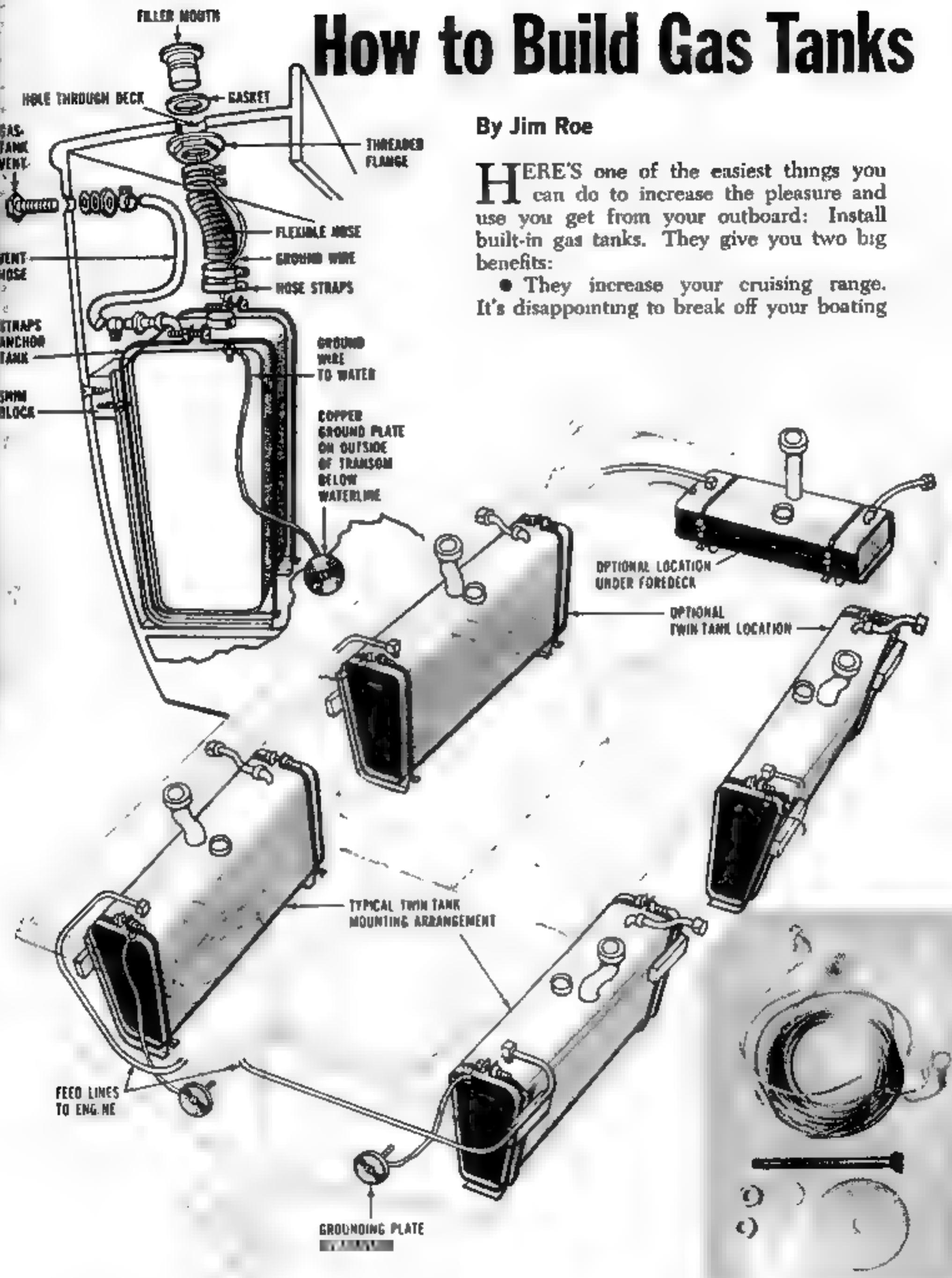
$$\text{Area of } 5^{\circ}\text{-dia. pipe: } 2.5 \times 2.5 \times 3.1416 = 19.635$$

How to Build Gas Tanks

By Jim Roe

HERE'S one of the easiest things you can do to increase the pleasure and use you get from your outboard: Install built-in gas tanks. They give you two big benefits:

- They increase your cruising range. It's disappointing to break off your boating



into Your Boat

in the middle of the fun to go back for more gas. Built-in tanks give you enough range for all-day skiing or extended cruises not possible with only the normal six or 12 gallons of fuel.

• They increase your safety. Extended range in itself makes your boat safer since it lessens your chances of running out of gas at a critical moment. And built-in tanks, properly installed, eliminate fueling hazards. They assure outside-the-cockpit fueling where spilled gas and fumes go over the side, not down into the bilge.

The rules say you are to take portable tanks out of the boat to fill them, but all too few boatmen do this. Since the average gas attendant will overflow or spill gas on every two out of three tanks he fills, you have a constant threat of gas fumes in the bilge. This is just as dangerous in an outboard as in an inboard.

Built-in tanks are relatively easy to install, but the job takes care. Electrical grounding is a must, and it's important that the filler pipe be located where spilled gas will drain overboard, not into the boat. Even at that, the job can easily be done in a spare afternoon, and will pay off for many years to come.

U-shaped brackets are fastened to side of hull first to anchor the tank securely. Kits include filler hose, deck fittings, all necessary hardware. Separate grounding kit (below, left) provides wire and special metal plate that bolts to the outside of the hull below the waterline.



PS BOATING

Long, slim tanks like this Tempo hug side of boat, take up little space. Some possible locations are shown in drawing on facing page.



Space for built-in tanks, like these hollow seat backs, is provided in many boats. Be sure, though, that enclosed tanks are ventilated.

Locate the filler pipe where no gas can spill into the boat. This raised coaming around the cockpit is an ideal spot for the filler mouth.



Short Cuts and Tips

FROM
PS
READERS

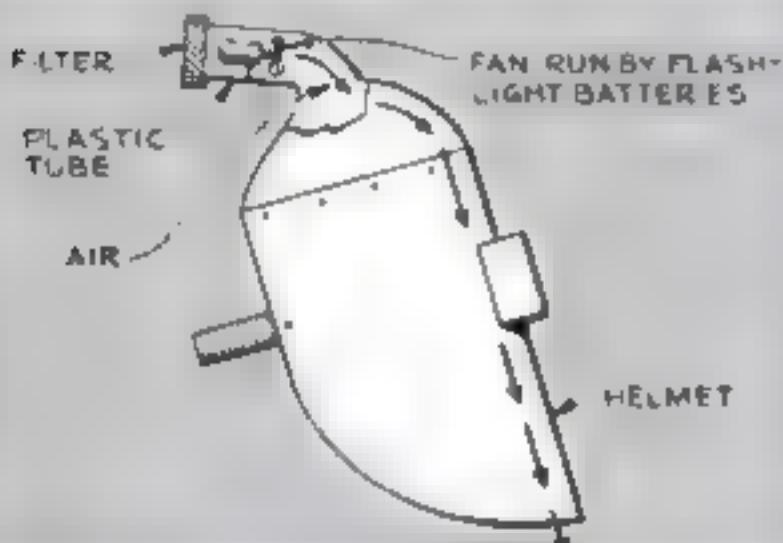
Roll-on stencil patterns speed decorating job

A midget paint roller—the kind sold for finishing small areas around trim—makes quick work of stenciling. It also demands less skill than dabbing with a stubby brush.

Use the roller fairly dry, rolling excess paint off on a newspaper. It's wise to clean the back edges of the cutout after

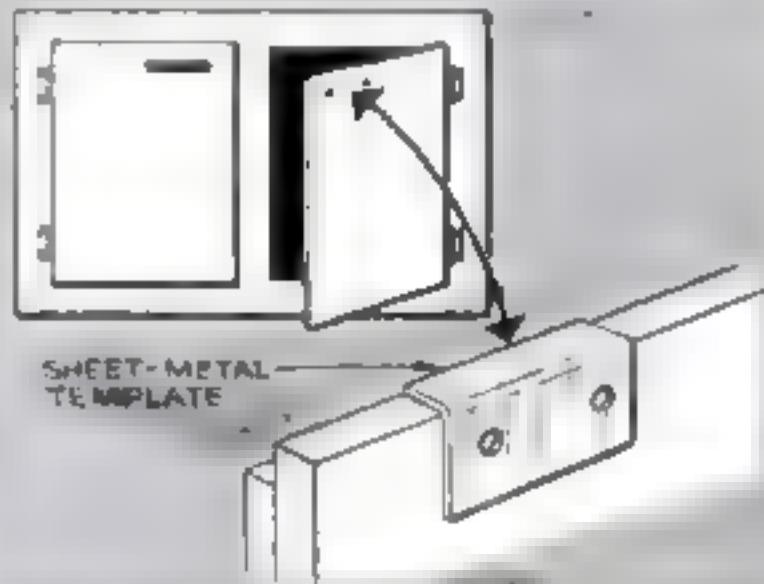


each transfer to prevent overrun. An aluminum TV dinner plate makes a handy paint tray.—Harry Walton, White Plains, N.Y.



Fan in helmet keeps welder cool

A welding helmet can become mighty stuffy and uncomfortable in some working conditions—and quite a few makers offer helmets with a system of supplied air. But Edward A. Wilson of Courtenay, British Columbia, has solved the problem himself—as shown in the sketch above from a recent issue of the *Welding Engineer*. Two flashlight batteries run a small fan in a plastic tube at the top of the helmet.



Template keeps hardware uniform

To insure uniformity in attaching hardware, such as handles on cabinet doors, I use this method. First I make a sheet-metal template for drilling the holes. Then I fold the edge of the metal to insure that the template will be precisely the same distance, from holes to door edge, for each handle.—Hugh Lineback, Tulsa, Okla.



Glass guides edging into place

When you're applying edge stripping, such as wood-veneer tape, to a table or counter top, it's a big help to have a piece of window glass projecting beyond the edge as shown at left.

The underside of the glass serves as a guide to bring the upper edge of the tape into perfect alignment with the upper table surface. It also lets you see what you're doing. The glass is moved around the table as taping progresses.—W. G. Waggoner, Sacramento, Calif.

SHOP TALK

By Sheldon M. Gallagher



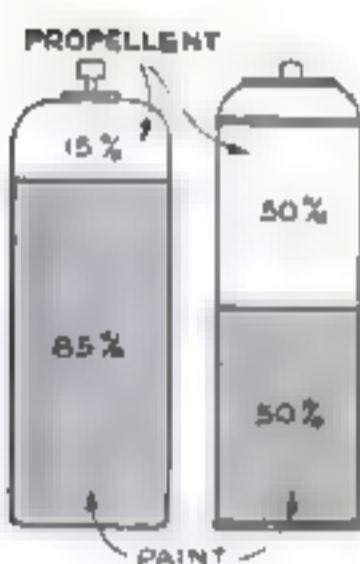
New way to lubricate shop machinery: paste-on "grease"



Here's one of the shiestest ideas we've seen in a long time. It's a solid-form lubricant that you just peel off a backing strip and wrap around a shaft, as at left. It works like a pressure-sensitive tape, holding lubrication in bearings or along sliding ways. Test strips are still going strong after a year with no overheating or wear. The big promise: fast, semipermanent lubrication of tools and machinery. The Ore-A-Tape was developed by Ore-Lube Corp., 126-06 18th Ave., College Point, N.Y.

Painting a concrete floor? Try this no-fuss etch

Picked up an interesting fact about etching concrete on a recent visit to Du Pont's research center at Wilmington, Del. The Du Pont people have developed a special chemical, called sulfamic acid, that does the same job as conventional etching acids but without the corrosive fumes or harmful effects to skin and clothing. The reason: It needs a much lower concentration to do its work and is thus safe and easy to use. Etching is important in preparing concrete for paint or tile mastic (to make sure the paint or tiles stick). The sulfamic acid can be bought at paint and hardware stores.



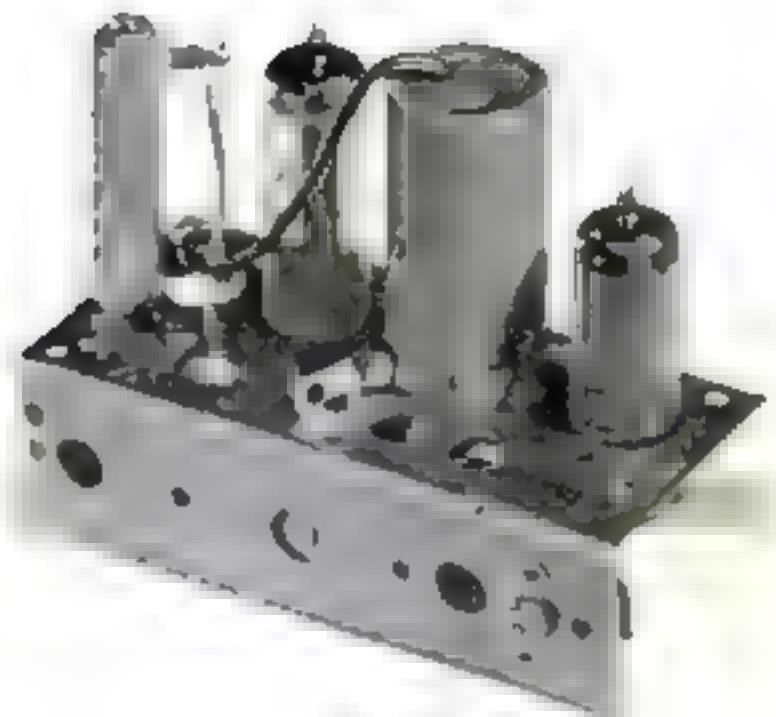
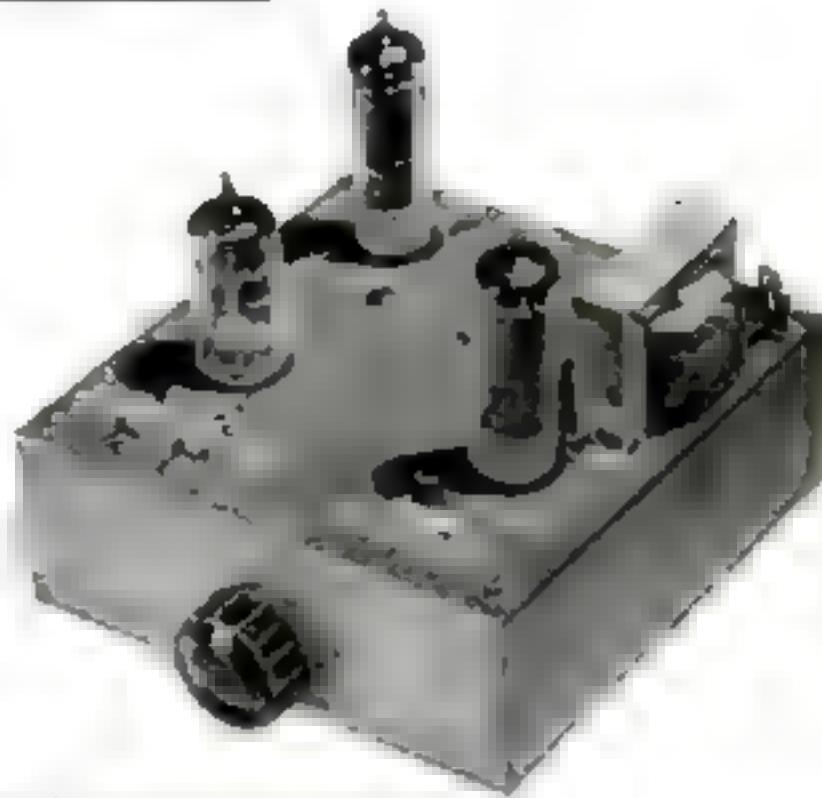
How they get more paint into the same size spray can

The BernzOmatic folks, famous for their handy propane torches, have come up with a new line of pushbutton spray enamels propelled by—what else?—propane. Because the gas is three times as powerful as conventional propellants, much less is needed in each can—only 15 percent compared with the normal 50 percent. Result: More space for paint, as at left. How come you can spray with an explosive gas? No problem, says BernzOmatic. The gas floats on top of the paint and does not come out of the can until the paint is gone. A nonflammable chemical is also mixed with the gas to keep it from burning. To prove it, there's even a propane fire extinguisher on the way. The new enamels come in 15 colors and in two sizes: 8 and 16 ounces, priced at \$1.79 and \$2.95.

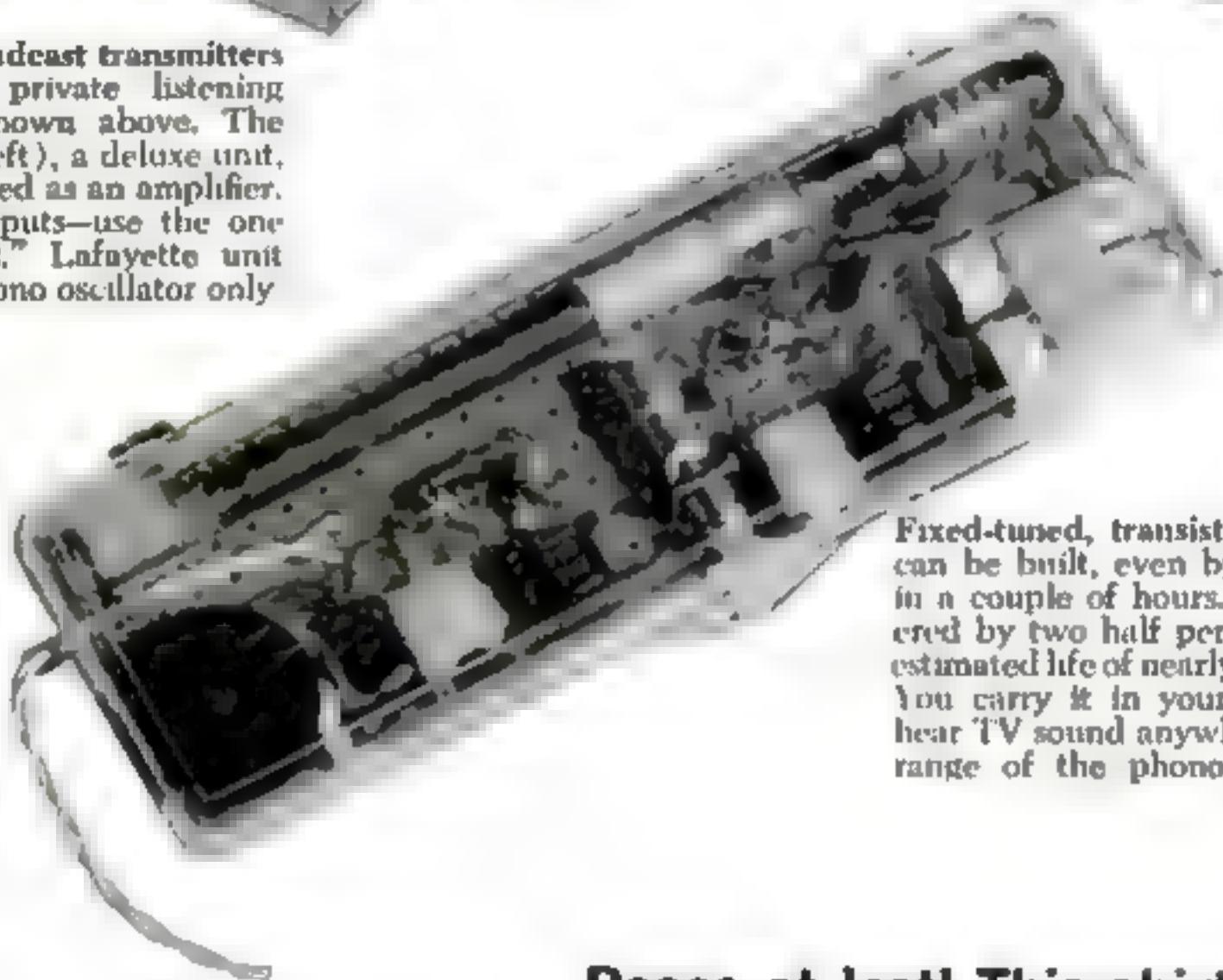


For cleaning muddy garden tools, make a dunk box

Now that the gardening season is almost upon us, the Stanley Tool people pass along this tip for keeping wet and dirty digging tools in good shape. Make a box about 18" square and fill it with a mixture of sand and old crankcase oil. After each use, plunge the tools into the sand a few times. The sand scrapes off mud, while the oil coats the metal to prevent rust . . . Two Stanley products good to know about are antirust oil and tree-pruning paint, both in handy spray cans. The pruning paint, out just this month, makes it easy to seal pruning cuts—and speed healing. It also serves as a wood preservative for posts and yard furniture.



Two tiny broadcast transmitters suitable for private listening system are shown above. The Knight-Kit (left), a deluxe unit, can also be used as an amplifier. It has two inputs—use the one marked "Xtal." Lafayette unit (right) is a phono oscillator only.



Fixed-tuned, transistor receiver can be built, even by a novice, in a couple of hours. It is powered by two half pen cells with estimated life of nearly 500 hours. You carry it in your pocket to hear TV sound anywhere within range of the phono oscillator.

All's Quiet on the TV Front

Peace at last! This shirt-pocket

By Howard G. McEntee

DO the blasting of gunshots and the whoop of Indians disturb your quiet when you want to read the evening paper—and the kids are deeply involved in a TV western? Or, with the shoe on the other foot, do you have to give up your favorite private-eye thriller while they do their homework?

Here's a happy solution to this typical family dilemma: With a new listening system, you can watch TV and hear the sound



transistor receiver delivers TV sound only to the viewer

loud and clear—while no one else in the room can hear it unless he wants to.

Private listening with earphones is, of course, not new. But the old way requires wires strung across the room that you can trip over. And when you leave the room, you have to disengage yourself from the gadget, perhaps missing an important bit of the sound.

Now, your earphone can go with you, and in most homes you'll be able to hear the sound anywhere in the house—a boon for mama if she wants to hear a cooking

class while she's busily doing the dishes.

The secret is a tiny radio transmitter that broadcasts the TV sound to a small transistor receiver in your pocket. The transmitter, known as a "phono oscillator," is available from radio-parts supply houses and is inexpensive. You can build the receiver from instructions given in this article.

To use this silent-listening system, you simply plug the input of the phono oscillator into a jack you mount in the side of your TV set. This silences the TV speaker and at the same time feeds the audio into

the transmitter. Switch on your personal receiver and you're ready to listen. You can have as many receivers as you wish; they won't interfere with each other.

No license is needed for these little transmitters, but still they must satisfy FCC requirements. The simplest and safest way is to buy a commercially made unit that has been checked out by the manufacturer and certified to comply. We list a couple that we bought and tried out.

The receiver you build uses a tuned RF (radio frequency) stage to amplify the weak signal picked up by the "energized loopstick" antenna. A transistor detector is followed by a single transistor AF (audio frequency) stage, which puts a potent signal into a hearing-aid-style phone (ordinary double headphones may be used, too, if you prefer). The only external control is R3—a volume adjustment that also has a built-in power switch. Properly tuned up, the receiver will give good volume many feet from the phono oscillator—how many is hard to say, as the signal seems, to some extent, to follow water pipes, power lines, and other metallic paths through the house. Anyhow, it will certainly work throughout the largest living room.

The receiver. We chose a long, slim shape for the receiver so it could be slipped into a shirt pocket and also allow a fairly long loopstick core to increase pickup. All parts are mounted on a perforated board. The plastic outer case originally housed a pen-and-pencil set.

Tiny eyelets are used as soldering points on the base plate. Fasten R3 with two flat-head, 2-56 screws. Make a circular cutout under it to clear the switch parts. Also cut away the base plate to make room for the two half pen cells.

Solder all parts except the loopstick before you solder the transistors into place. Solder the transistor leads directly to the eyelets, holding the wires tightly with long-nose pliers to prevent overheating the transistors.

C3 is the regeneration control. As you get it, this capacitor is intended for vertical mounting on a metal chassis, and some changes are needed (see sketches, right). Mount the capacitor body horizontally on the base, using an angle bracket to hold the adjustment screw. A 6-32 tapped hole carries this screw, and a slot through the bracket allows the sides to be squeezed together enough to put tension on the

screw. This assures good electrical contact and holds it at the desired setting.

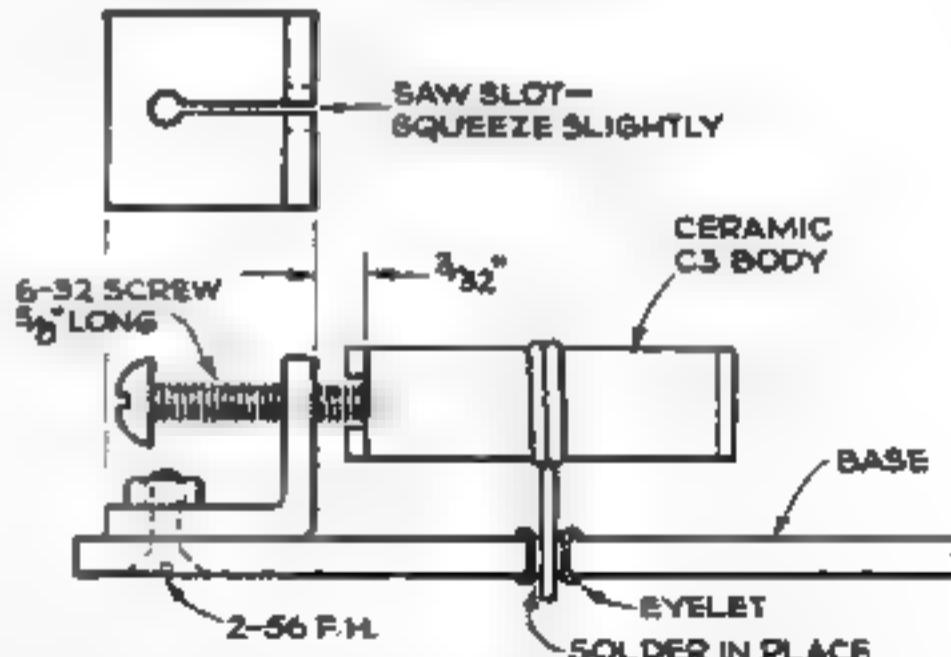
The antenna. Considerable modification is needed on the loopstick. You can't buy such a unit with a core near 5" in length, so the next best bet is to get one with a 7" core, and cut it to size. The drawings show the changes needed.

The loopstick assembly goes on last. Be sure to leave the leads long enough so the assembly can be slid all the way from one end to the center of the core. The transformer, TR, must also be modified. Carefully bend back the tabs on the bottom and pull out the entire coil assembly. Under a thin strip of phenolic you will see a subminiature capacitor. This must be removed from the circuit. Easiest way is simply to crush it, making sure the ends of the capacitor are completely isolated. Reassemble and mount TR on the base with a dab of glue. Don't try to bend the connecting pins—they'll break off.

The transmitter. When you have completed the wiring, you're ready to tune up. For this you'll need your little transmitter operating. We tried two different commercially available units (Lafayette #PK-25, \$4.50 ready to use; and Allied Radio's Knight-Kit #83 Y 706-J, \$12.95). Both were satisfactory, but we had to add a 50mmf. capacitor across the tuning element of the Lafayette job to get it to tune to the lower end of the broadcast band. The Knight-Kit is the most deluxe phono oscillator we could find, but, of course, you have to put it together. It has a some-

CONTINUED

Fixed-tuned transistor



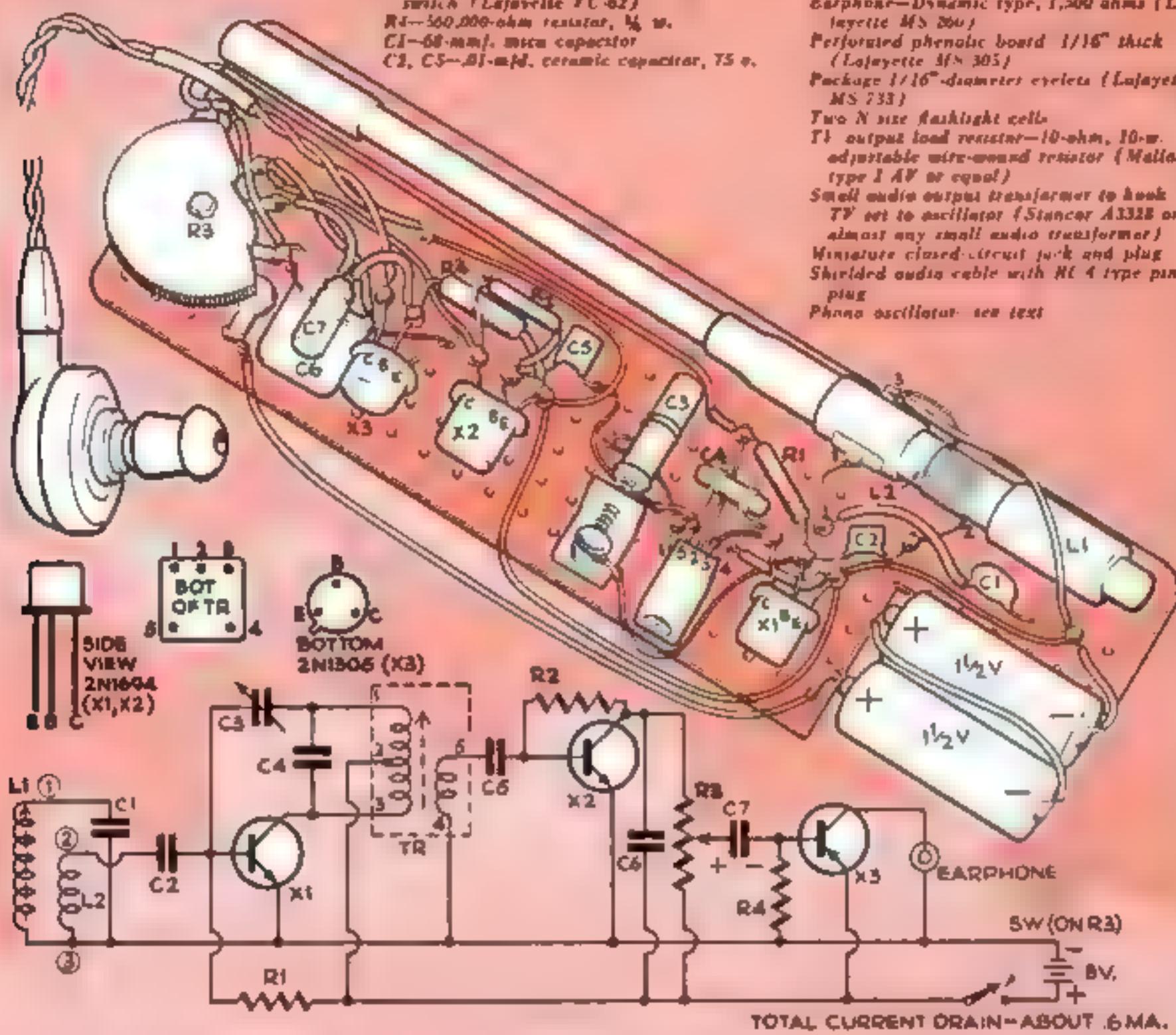
Tubular trimmer capacitor controls regeneration. Turn the screw to vary capacity. Use a small angle bracket tapped for a 6-32 screw, saw slot, and squeeze to put tension on screw.

PARTS LIST

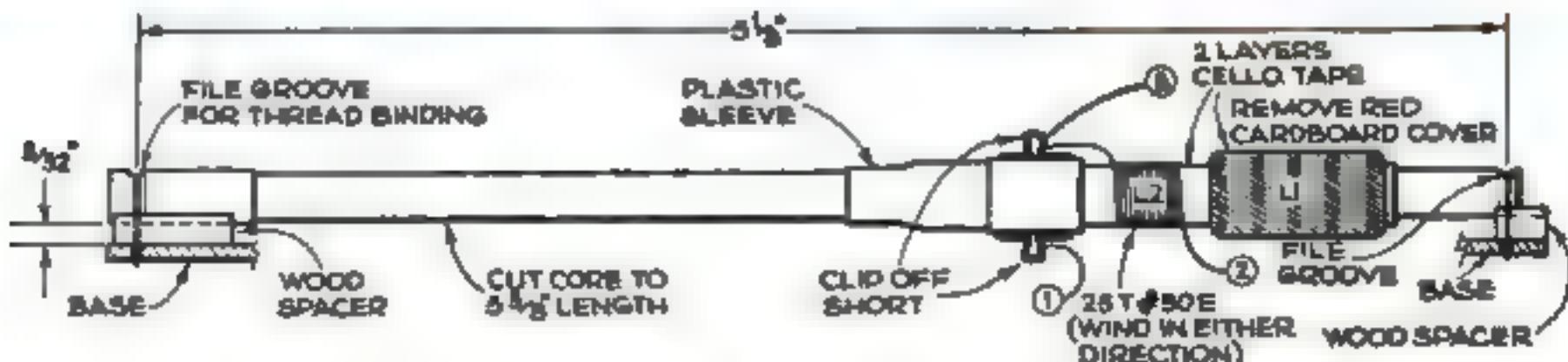
X1, X2—Transistors, GE 2N1694 NPN
 X3—Transistor GE 2N1305 PNP
 L1—7" loopstick (Lafayette MS-44)

TR—Subminiature IF transformer (Lafayette MS-776)
 R1—300,000-ohm resistor, $\frac{1}{2}$ w.
 R2—2 megohm resistor, $\frac{1}{2}$ w.
 R3—3,000-ohm variable resistor with switch (Lafayette FC-62)
 R4—300,000-ohm resistor, $\frac{1}{2}$ w.
 C1—0.01-mfd. mica capacitor
 C2, C5—.01-mfd. ceramic capacitor, 75 v.

C3—5-to-3-mfd. ceramic trimmer capacitor
 C4—18-mfd. mica capacitor
 C6—.05-mfd. ceramic capacitor, 75 v.
 C7—2-mfd. electrolytic capacitor, 6 v.
 Earphone—Dynamic type, 1,500 ohms (Lafayette MS-200)
 Perforated phenolic board 1/16" thick (Lafayette MS-305)
 Package 1/16"-diameter eyelets (Lafayette MS-733)
 Two N size flashlight cells
 T1—output load resistor—10-ohm, 10-w. adjustable wire-wound resistor (Mallory type 1 AV or equal)
 Small audio output transformer to hook TV set to oscillator (Stancor A332B or almost any small audio transformer)
 Miniature closed-circuit jack and plug
 Shielded audio cable with MC-4 type pin plug
 Phono oscillator—see text



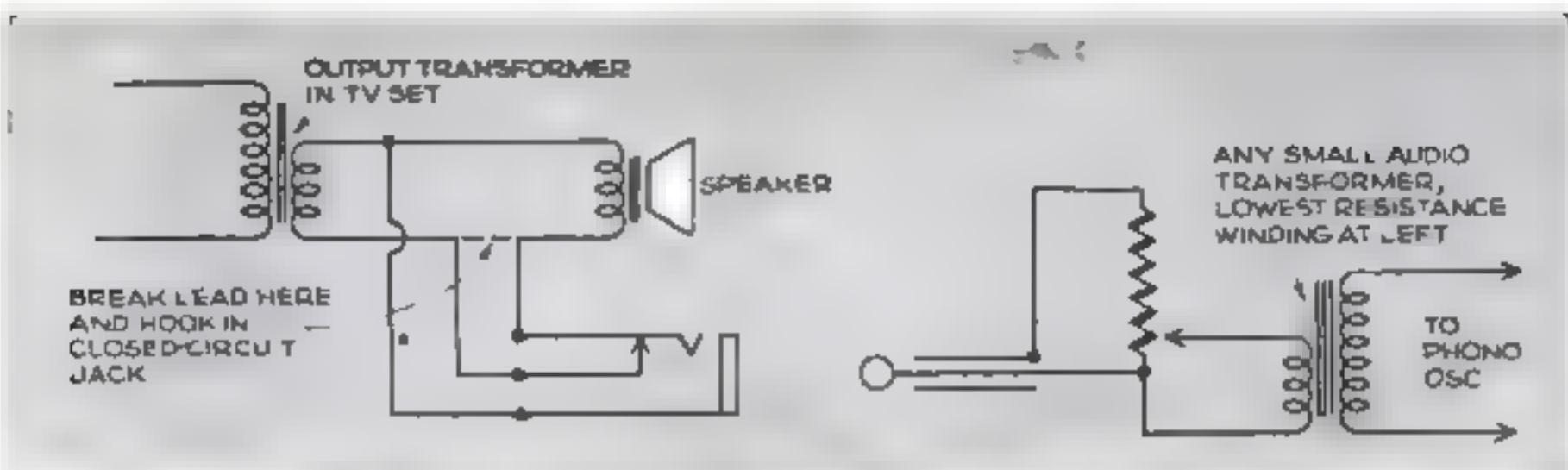
receiver is simple enough for anyone to build



Loopstick size and adjustment greatly influence sensitivity of receiver. By using a 7" loopstick, cutting it exactly to fit your case, and modifying it so it can be accurately tuned to one frequency, you get much better sensitivity than with a smaller one used "as is". The core material is quite hard. To cut it, file a groove all the way around the rod and break it with a sharp rap. Tune by sliding the entire winding assembly along the core. To get a reasonable tuning range,

L1 must be movable as close as possible to one end of the core. Mount rod with wooden spacers so that the core is about $\frac{3}{8}$ " from base. File grooves at each end to receive thread binding that holds rod. Before binding, smear model cement on the parts to hold assembly firm. Remove the red cardboard cover from L1 and wrap it with two layers of cellophane tape. Wind L2 as indicated and wrap it with tape, too. Connect the ends of L2 as shown here.

How to connect the transmitter to your TV set



Connect to TV set with a closed-circuit jack and plug. Wire jack across lead to speaker voice coil as shown. If TV cabinet is metal, be sure to insulate jack with insulating washers. Output load

resistor and transformer can be mounted in a separate box or you can place it inside the cabinet you make to house the oscillator. Use only shielded cable for the audio leads.

what stronger output than the \$4.50 unit.

The diagram directly above shows you how to hook up the oscillator to your TV set. Both of these phono oscillators use transformerless circuits (like table-model radios) so their metal chassis should be treated as though they were one conductor of the power line. For safety, you should enclose them in a wooden box or cabinet. Avoid touching any metal object that might be grounded when there is any chance you might be in contact with the oscillator chassis. Mount the unit so it can't be reached by children.

Tuning the system. With the oscillator on, set TV volume control about midway and the variable resistor across the TV output near the bottom of its range. With your receiver on and held near the oscillator antenna, move L1-L2 near the center on the core and set the adjustment screw of TR at midpoint. The screw of C3 should be just at the point of entering the tubular capacitor. Turn the tuning adjustment of the oscillator through its range and you should pick up the TV sound at some point. When you do, adjust L1 and TR for maximum volume. Move across the room and repeat the adjustment of L1 and TR. Finally, move as far as possible from the antenna while still getting a signal and adjust C3 for maximum volume. If you hear a squeal, back off slightly on the adjustment.

If you get interference from a local broadcasting station at the frequency you have chosen, try another frequency. You may have to work back and forth several times, between the oscillator and the receiver, before you get a clear, clean signal.

You should get a definite peak in volume when you adjust the tuning of your receiver. That is, for a given setting of the oscillator tuning control, you should find a position for L1 and TR such that a movement in either direction will result in a loss of volume. If you don't get a definite peak, the oscillator frequency is beyond the range of the receiver. Move the tuning control on the oscillator and try again.

The sound you hear in your earphone should be clear. If it seems muddy or distorted, you are probably overloading the phono oscillator. Try various combinations of settings of the TV volume control, the output-level control, and the input control on the oscillator, if it has one.

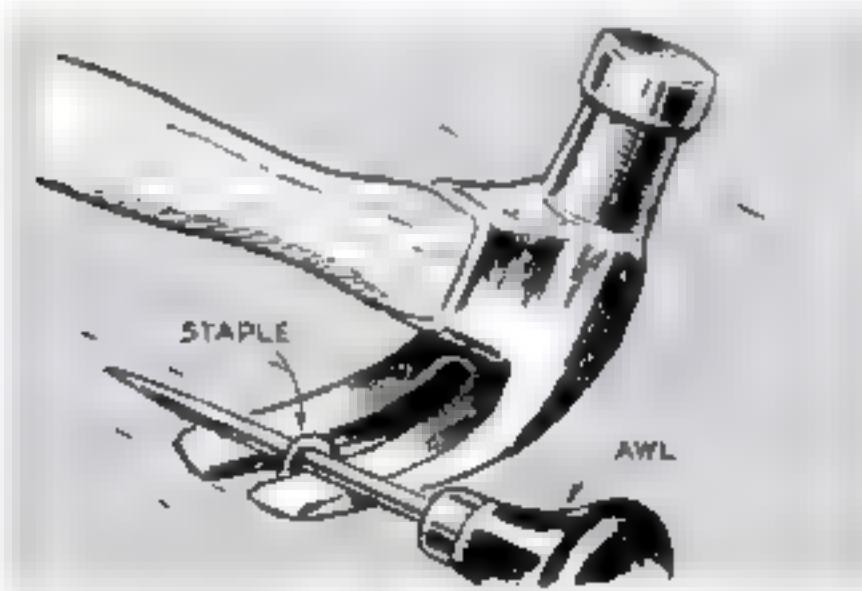
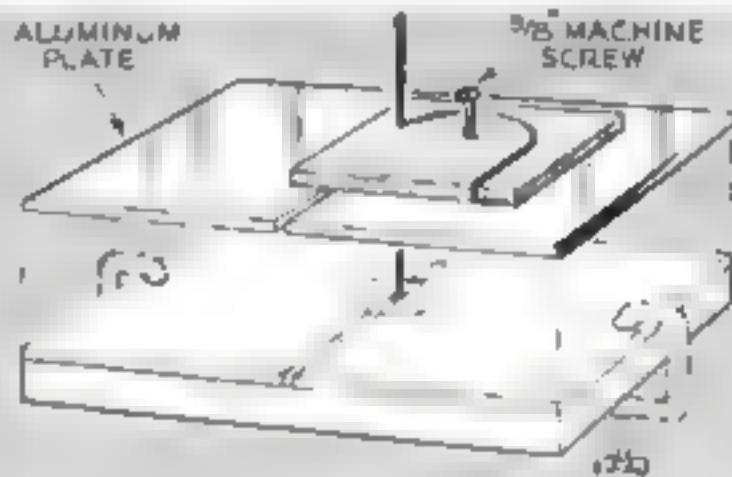
The oscillator antenna should be placed as near as possible to the center of the desired pickup area. Under the floor or above the ceiling are usually desirable locations, although we found there was signal strength to spare in most installations with the transmitting antenna simply strung along a wall. The receiver antenna is quite directional, so you'll find a considerable difference in range depending on how you hold the receiver.

Keeping within the law. The FCC regulations require that the power radiated by unlicensed transmitters, such as these, be strictly limited. The manufacturers of phono oscillators must certify that their units will not exceed these limits when used as directed. The directions are mainly concerned with the length of antenna used. If you use a longer antenna than specified, you may interfere with your neighbor's radio, and that could get you into trouble with the FCC. ■ ■



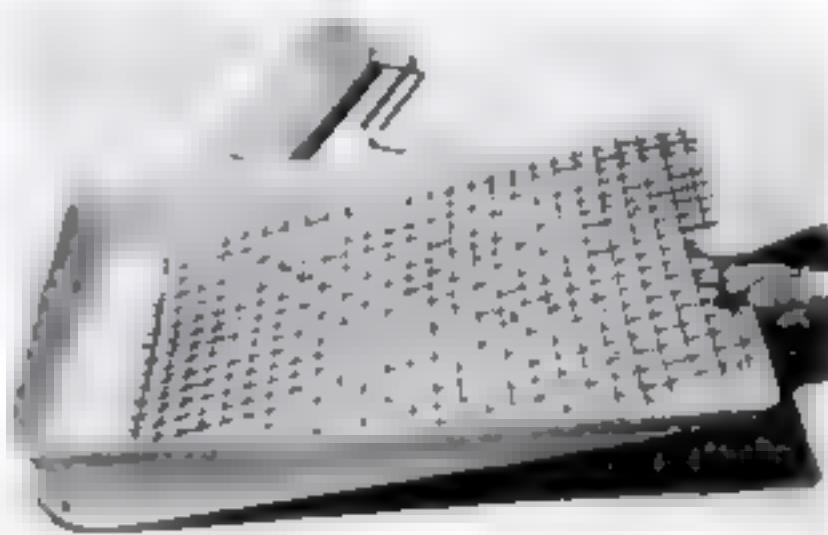
A setup for cutting disks fast

The job of cutting a lot of 4" wooden toy wheels went fast with this jigsaw setup. The wood blocks were pivoted on a pin placed in an aluminum plate 2" from the blade. (The distance of the pin from the blade determines the radius of the disk.) The aluminum plate has a slot so that it can be slid into place. A freehand cut is made to the edge of the circle.—R. A. Pollock, Staten Island, N. Y.



A good trick for pulling staples

Here's a way to avoid damage to wood surfaces when pulling out staples. Insert the tip of an awl through the staple, place the hammer claws under the awl, and exert leverage on the hammer handle.—Daniel Bousha, Jackson, Mich.



Nonskid surface for a paint roller

A paint roller won't skid in the tray if you line the bottom with a piece of $\frac{1}{8}$ "-mesh hardware cloth before you start. The hardware cloth also helps to distribute the paint more evenly on the roller for a better job.—William Swallow, Brooklyn, N. Y.

Move In Close

there's a wealth of detail within the 3-foot range

By Bob Hering

YOU'VE missed a lot of fun in photography if you've never moved in close to a subject. There's dramatic impact in a frame-filling photograph. Try it. It's surprising what you see from this vantage point.

What is a close-up? Basically, it's recording on film a more detailed image than you can see with the naked eye. Except when using extreme telephoto lenses, you work close—three feet or less—to the sub-



ject. The closer you get, the smaller the area included.

Whether you're interested in copying for record, producing artistic compositions, or shooting close-ups just for the fun of creating an image bigger than life, there are certain basics to know.

You can start with simple equipment—even an inexpensive fixed-focus camera and close-up lens. If shooting close-ups arouses your interest, you can then buy more elaborate gear. Only a small area is needed for photographing. Usually a setup can be left standing until you're satisfied—it's there to work with at your leisure.

This tiny world of the close-up demands attention to details—focus, lighting, composition, and exposure. By the time you're shooting consistently good close-ups, you'll have the technical side licked. You can then concentrate on subject matter and composition, confident of making sharp, clear pictures.

Entering the nearsighted realm of the close-up requires reorienting your thinking. You'll need to look close at everything,



develop an awareness of the detail in the world about you. Subjects are everywhere: in the home, the garden, the woods. Tiny subjects can become giants on photographic paper. Typical are those too small to see

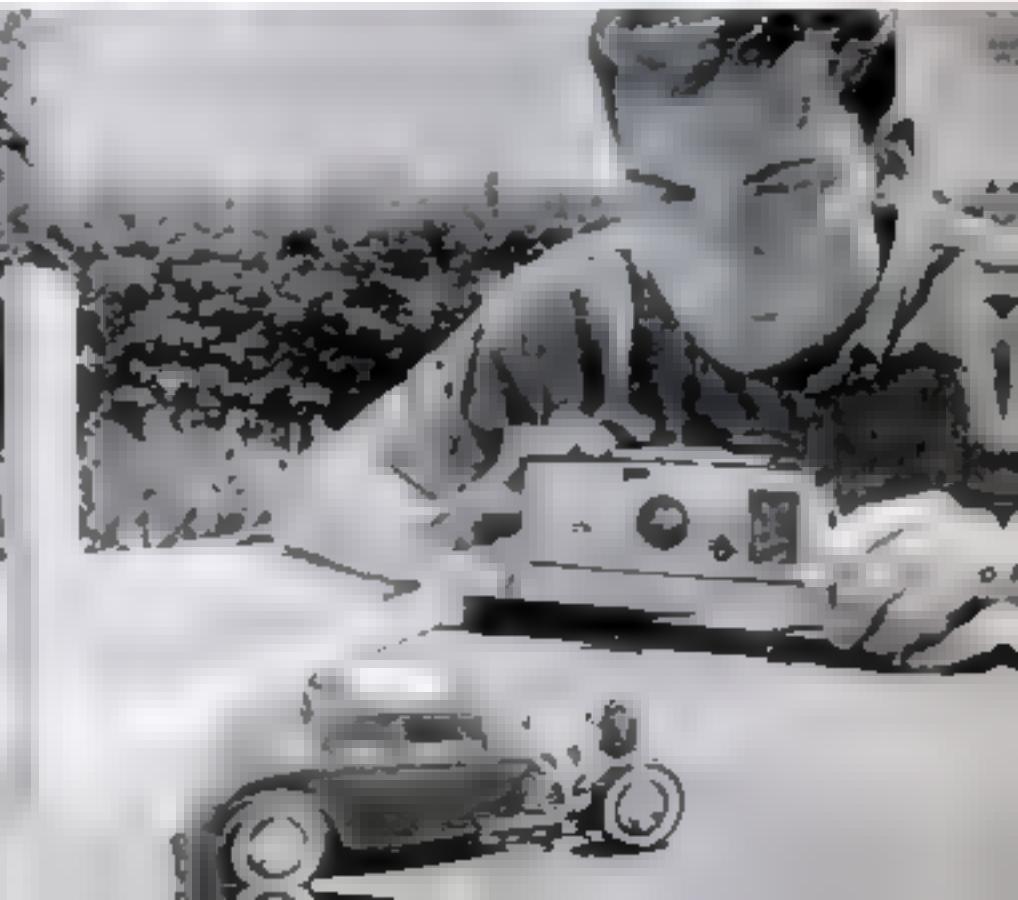
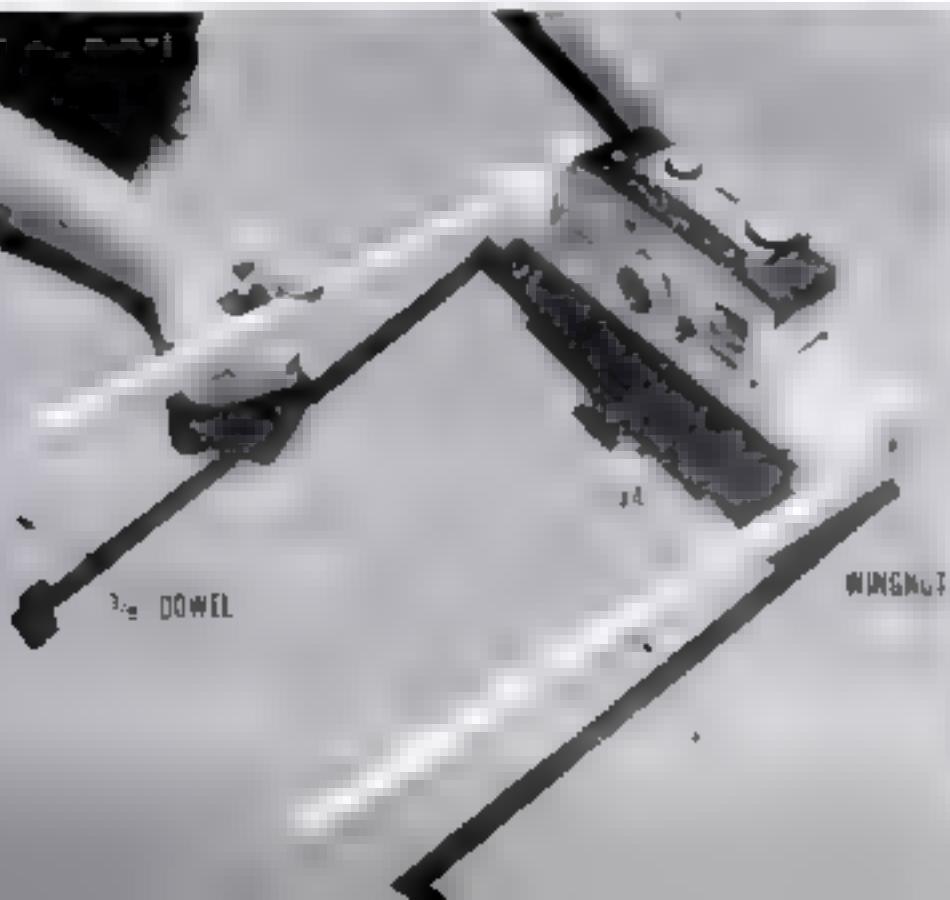
clearly when viewed from a normal distance—small plants and animals, flowers, leaves, and insects to name a few. Include a finger or some other common object to indicate scale when photographing extra-

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Focal frame measures off working distance and locates picture area

A simple wood or metal frame, laid out according to the lens-to-subject distance and the picture-area dimensions (usually supplied with supplementary lens), makes a practical range

and view-finder. Everything inside the frame will appear in the picture. Use dowels or nails to extend the uprights to top of picture area. Push far end of frame close to the subject



small objects. Try an extreme close-up of one of your favorite pets napping. People's faces—or even just their eyes—make good studies. There's subject matter aplenty once you train your eyes to look for it.

Which camera? Most cameras are adaptable to close-up work, but, for best results, two features are important: a ground glass for viewing and focusing, plus some means of extending the lens, by bellows or extension tubes.

A ground glass shows the exact area the film records. Focus is so shallow at 1:1, for example, that only ground-glass focusing assures sharpness. Providing a way to physically extend the lens, as in a view camera, cuts out the need for supplementary lenses.

Single-lens reflex. Of the roll-film cameras, the most versatile for close-ups and copying is the single-lens reflex. Whatever you see through the lens is recorded on the film—you can focus precisely on the ground glass, or on a prism viewfinder.

The SLRs that accept interchangeable lenses can use bellows, tubes, or tele lenses for close-ups. But on the leaf-shutter SLRs, which do not accept interchangeable lenses, supplementary or front-element convertibles are used. For hand-holding on a field trip, no camera compares with the single-lens reflex.

Rangefinder. Next in convenience for close-up work is the rangefinder camera

These attachments outfit



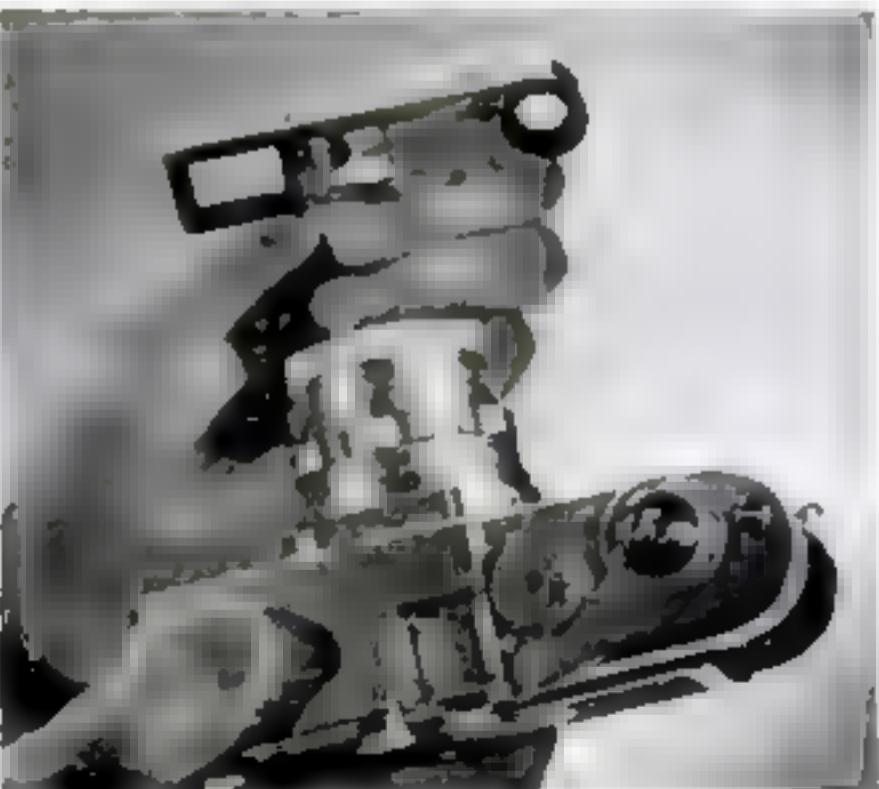
Bellows attachment, combined with the ground-glass focusing of the SLR, provides the most flexible way at close range of physically extending the lens and composing the image.

that accepts interchangeable lenses. But here for through-the-lens viewing and focusing you need an auxiliary reflex housing—at close distances without through-the-lens viewing the camera viewfinder sees a slightly different picture than the camera lens. This is known as parallax error.

The reflex housing is bulky and fairly expensive. You may decide that it's more feasible to pick up a moderately priced single-lens reflex instead of adding a housing.

When a reflex housing is not used, some

To adapt rangefinder cameras for close-up work, add these



Rangefinder cameras with removable lenses accept reflex housings and either bellows extensions or extension tubes. The setup gives you all the advantages of a single-lens reflex camera.

For hand-holding rangefinder cameras in close, there are several devices. The one above has parallax adjustment that allows you to work directly through the camera's own optical system.

single-lens reflex cameras for close-up work



Extension tubes, used in combinations, offer a variety of lens-to-film ratios. They are inexpensive, but their fixed lengths limit their focusing range compared with bellows.

sort of supplementary viewfinder is needed for the rangefinder camera. It can be a simple wood or metal frame, or one of the more precise optical supplements.

Twin-lens reflex. For general photography, the twin-lens reflex is a favorite, but it presents problems for close-up photography. Usually there's sufficient parallax correction for distances from three feet to infinity. But for closer work, a twin-lens reflex lacks the advantage of interchangeable lenses (except the Mamiyaflex),



Most leaf-shutter reflexes require supplementary lenses, but Contaflex Super B (above) uses lenses with removable front elements. This lens can take a big 1:1 image (actual size).

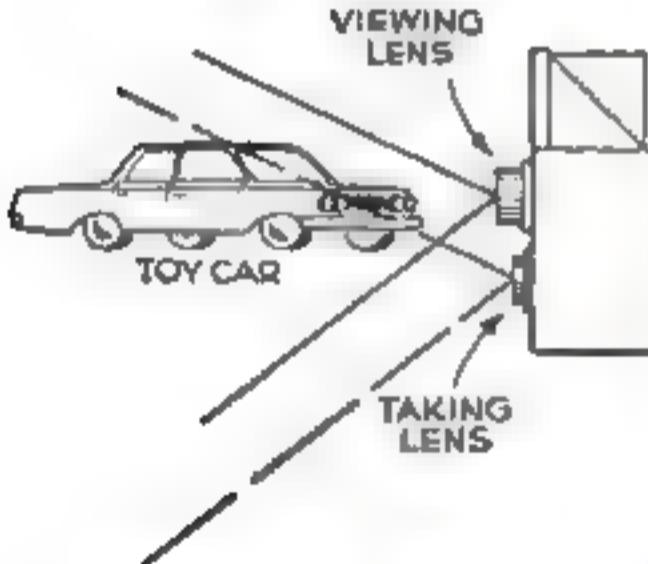
and the parallax error increases as you move in.

For moderate close-ups, you can add matched supplementary lenses to both the viewing and camera lenses. For extremely close work, the twin-lens camera is impractical. It requires a special optical or mechanical accessory to correct parallax.

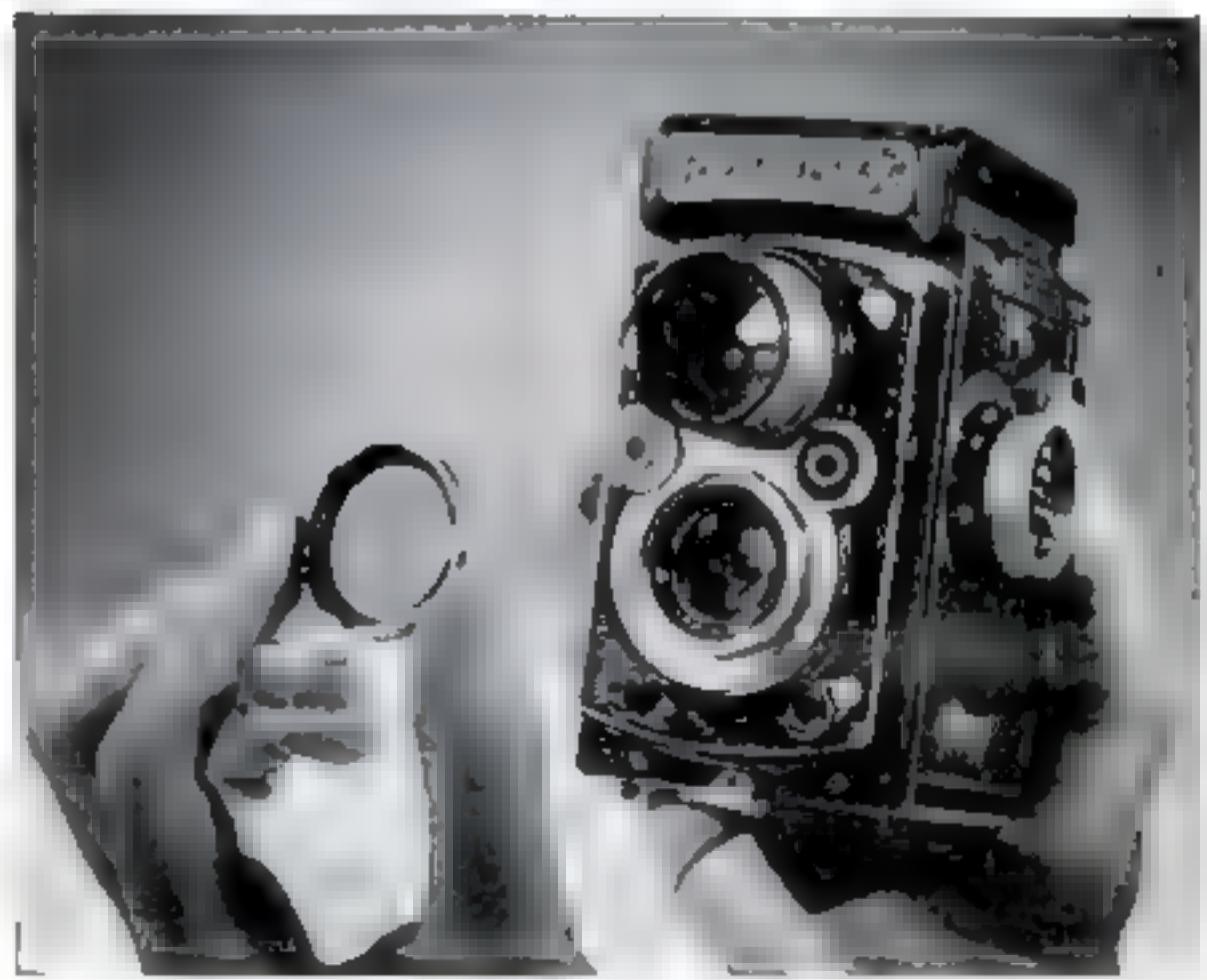
Fixed-focus and others. Fixed-focus and other inexpensive eye-level cameras without interchangeable lenses are the least adaptable to close-up photography. To use them,

CONTINUED

Twin-lens reflexes require parallax correction



Parallax error with twin-lens reflex is illustrated above—at close range, lenses see different pictures. Supplementary lens over viewing lens, at right, has prism that refracts rays so you see what taking lens, with its supplementary, will catch.





you must add a supplementary lens and some device to solve the parallax problem. For this purpose, a simple focal frame can be rigged up from metal rods, wire, or wood strips. Such equipment, however, should be confined to shooting moderate close-ups.

What about focus? Whenever you focus a camera, you alter both lens-to-film and lens-to-subject distances. At normal shooting distances, these changes are easy to handle. But as you move closer than 3', it becomes more difficult to focus accurately—and depth of field decreases sharply. Sharpness may extend only a fraction of an inch from the plane of sharpest focus. With a 2" lens on a 35mm camera, for example, the depth of field at a distance of 18", with the diaphragm stopped down to f/8, is slightly less than 1". In extreme close-ups, there's practically no depth of field. No wonder focusing is so critical.

The big image. To get a larger-than-normal image on film, you need a way of extending the focusing range of your camera. This requires certain accessories to increase the distance from lens to film.

You have several choices: You can physically extend the lens with bellows or extension tubes; you can optically shorten the normal focal length with positive supplementary lenses; or you can use a telephoto lens.

Supplementary lenses. Looking much like a filter, a supplementary lens is the least expensive and simplest close-up accessory.

Flowers are favorites for color slides

One of the most popular subjects among camera fans who shoot color slides is flowers. And the most dramatic way to portray them is by moving in close until a single bloom—or a few at most—practically fills the frame. Jackson and Perkins, rose specialists, suggest photographing blooms $\frac{1}{2}$ open, from a camera angle partially looking into the center of the flower. An overhead light gives best basic illumination, with other lights as needed. John Staby shot prize-winning Tropicana rose (left), using this lighting method to emphasize texture.

When placed over a camera lens, a positive supplementary lens reduces the focal length. These lenses come in strengths of 1+ to 10+ and in a variety of sizes and mounts, usually fitted to specific cameras. A supplementary lens decreases definition slightly, especially if it is one of the stronger plus lenses (6+ to 10+). It's desirable, for this reason, to work with the main lens system stopped down two or three openings to increase depth of field and sharpness.

A big advantage of supplementary lenses, in addition to low cost, is that

[Continued on page 224]



Metal copy stand functions like a focal frame, holding the camera at a predetermined distance from the subject to be copied. The legs indicate the corners of the picture area.

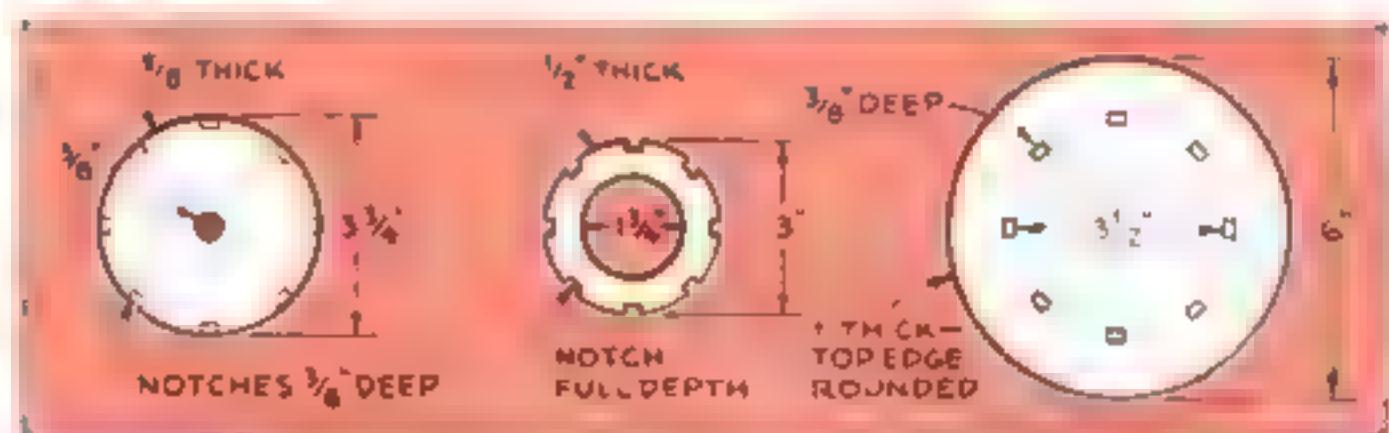
Strips and Disks

Make an Airy Lamp

THIS lamp was designed for use where there is need for an airy fixture blending well with modern furniture. It's built of contrasting woods—eight $\frac{3}{8}$ "-by- $\frac{1}{4}$ "-by-15 $\frac{1}{2}$ " mahogany strips and three birch disks. A rear strip hides the wire.

Locate notch positions on the disks by drawing four diameter lines across each one, spacing the lines 45 degrees apart. Space the notches in the base on a 1 $\frac{1}{2}$ " radius from the center. On the center and top disks cut notches on the edges, those on the top one only part way through. Glue the strips to the middle disk first, clamp, and let the glue set before curving out the strips to suit the other disks.

Mount the bulb socket on a piece of



threaded fixture tubing run through a $\frac{1}{4}$ " hole in the top disk and held with a hex nut.—Jorma Hyypia, Greenwich, Conn.



Using all the kitchen space

The spice cupboard above was created from the most-often-wasted space in any kitchen—the area behind the panel concealing the sink. A magnetic catch holds the door shut. The recess has a hardboard back.—Leonard Kamerer, Tallmadge, Ohio.

A key caddy for your wallet

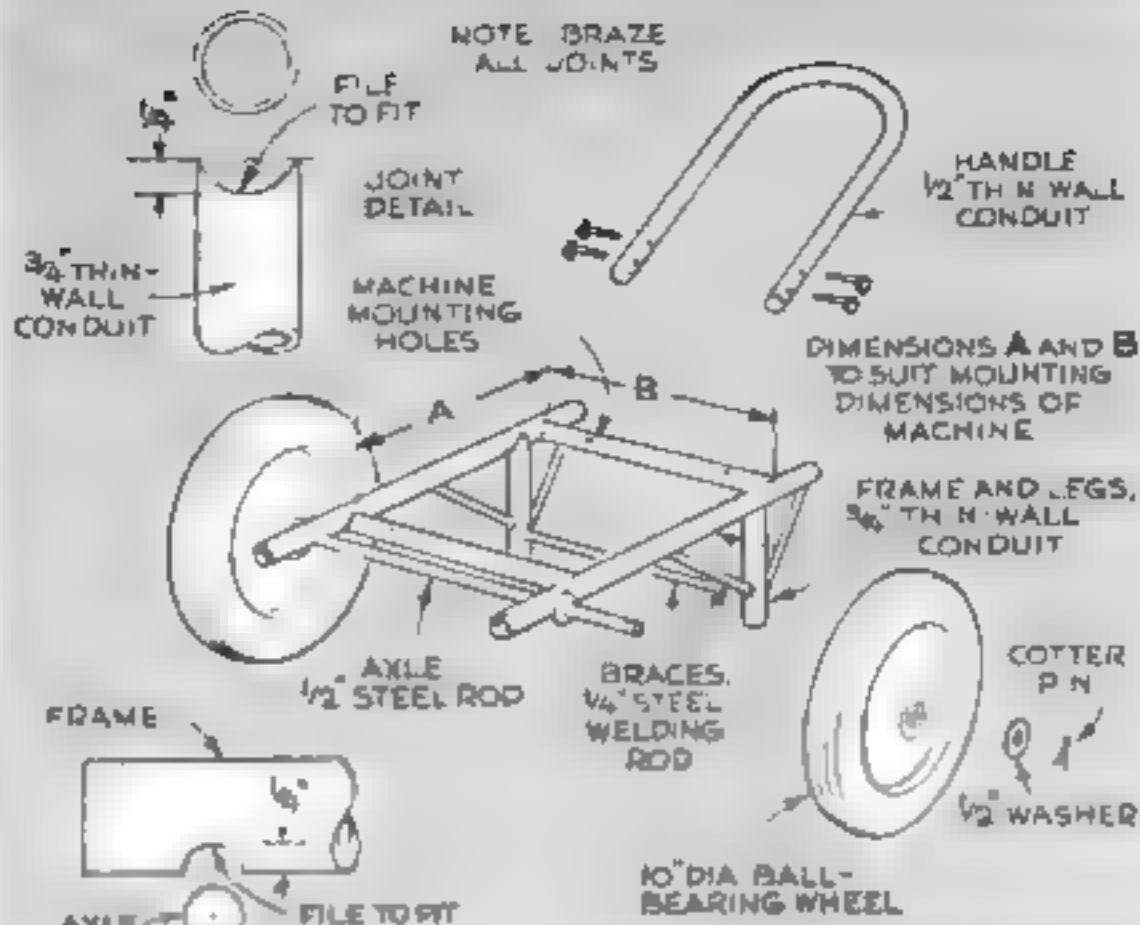
Keeping four or five keys in a wallet may seem impossible. However, a caddy made from flexible leather is thin enough to slip into a wallet without bulking.

Use leather at least $\frac{1}{16}$ " thick. Fasten each key with a brass eyelet. Compress the eyelet just enough to let the key move freely on it.—Robert Micals, Freehold, N.J.



Short Cuts and Tips

FROM
PS
READERS



A carriage for compressor or welder

Small air compressors, welding outfits, and other machines are often too heavy to be handily portable. This homemade carriage, adapted to a particular machine, will put it on wheels for maneuvering wherever you want it.

The carriage makes use of standard utility wheels (10" by 1.75) and $\frac{1}{2}$ " and $\frac{3}{4}$ " thin-wall conduit and steel rod—all avail-

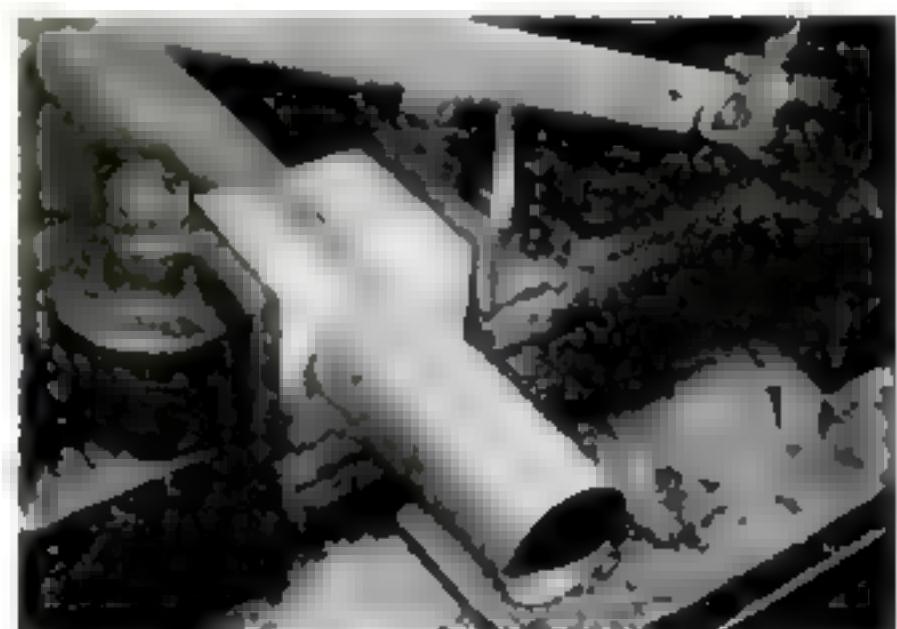
able at hardware stores. Dimensions of the carriage you'll want depend on the size of your machine.

Use a $\frac{1}{2}$ " round file to bring the frame joints to a close fit with the joining member, a $\frac{1}{8}$ " file to fit the axle. Braze all the joints if you're equipped for that, or have them welded professionally. Use $\frac{1}{2}$ " washers on each side of each wheel, and drill the ends of the axle to take cotter pins.—Manly Banister, Portland, Ore.



How to repair an ignition switch

Ignition trouble may result from worn or grooved contact surfaces in the ignition switch. If you can't get a new switch, or if you'd simply like to make the old one serve longer, fill the worn areas in the contact points with solder. For longer service, hammer a piece of copper wire flat, solder a tiny sheet of it over each one of the stationary contacts, and dress down the edges.—Ken Murray, Colon, Mich.

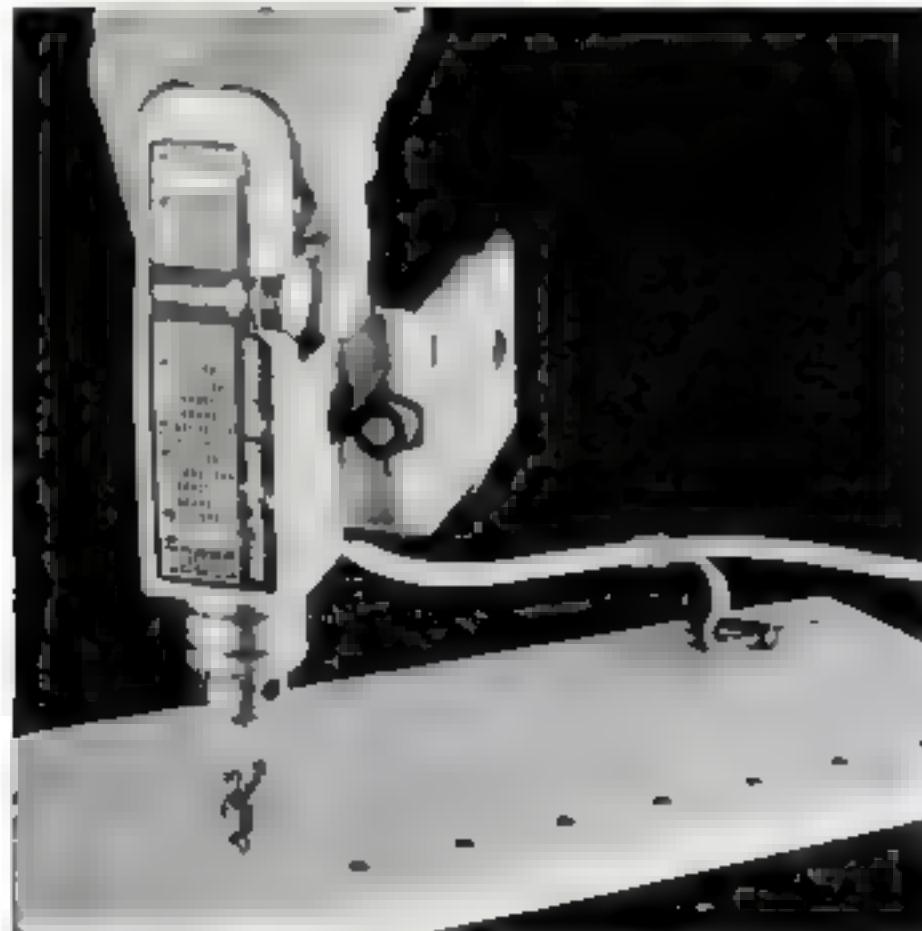


Wood blocks hold tubing for hacksaw

Production hacksawing of thin-wall tubing is easy if you use form-fitting hardwood grip blocks like these to prevent marring and crushing the stock in the vise or clamp jaws.

The blocks shown were cut out of hard maple. The circular gripping inner faces were sawed into the blocks with a narrow blade on a metal-cutting bandsaw.—H. J. Gerber, Menomonie, Wis.

DRILL SIZE	BRASS	BRASS	C.L. SOFT	C.L. HARD	MILD STEEL	IRON	WOOD PASTE
1/16	H.S.S.		1	1	1	—	
1/8	C.S.		1	1	2	1	1
1/4	H.S.S.		1	1	2	4	1
3/8	C.S.	3	7	7	3	8	2
1/2	H.S.S.	3	7	7	3	8	4
5/8	C.S.	7	11	11	7	11	7
3/4	H.S.S.	7	11	11	7	11	7
7/8	C.S.	11	15	15	11	15	11
1	H.S.S.	11	15	15	11	15	11
1 1/8	C.S.	15	21	21	15	21	15
1 1/4	H.S.S.	15	21	21	15	21	15
1 1/2	C.S.	21	27	27	21	27	21
1 5/8	H.S.S.	21	27	27	21	27	21
1 3/4	C.S.	27	33	33	27	33	27
1 7/8	H.S.S.	27	33	33	27	33	27
1 15/16	C.S.	33	39	39	33	39	33
1 13/16	H.S.S.	33	39	39	33	39	33
1 11/16	C.S.	39	45	45	39	45	39
1 9/16	H.S.S.	39	45	45	39	45	39
1 7/16	C.S.	45	51	51	45	51	45
1 5/16	H.S.S.	45	51	51	45	51	45
1 3/16	C.S.	51	57	57	51	57	51
1 1/16	H.S.S.	51	57	57	51	57	51
1 1/16	C.S.	57	63	63	57	63	57
1 1/16	H.S.S.	57	63	63	57	63	57
1 1/16	C.S.	63	69	69	63	69	63
1 1/16	H.S.S.	63	69	69	63	69	63
1 1/16	C.S.	69	75	75	69	75	69
1 1/16	H.S.S.	69	75	75	69	75	69
1 1/16	C.S.	75	81	81	75	81	75
1 1/16	H.S.S.	75	81	81	75	81	75
1 1/16	C.S.	81	87	87	81	87	81
1 1/16	H.S.S.	81	87	87	81	87	81
1 1/16	C.S.	87	93	93	87	93	87
1 1/16	H.S.S.	87	93	93	87	93	87
1 1/16	C.S.	93	99	99	93	99	93
1 1/16	H.S.S.	93	99	99	93	99	93
1 1/16	C.S.	99	105	105	99	105	99
1 1/16	H.S.S.	99	105	105	99	105	99
1 1/16	C.S.	105	111	111	105	111	105
1 1/16	H.S.S.	105	111	111	105	111	105
1 1/16	C.S.	111	117	117	111	117	111
1 1/16	H.S.S.	111	117	117	111	117	111
1 1/16	C.S.	117	123	123	117	123	117
1 1/16	H.S.S.	117	123	123	117	123	117
1 1/16	C.S.	123	129	129	123	129	123
1 1/16	H.S.S.	123	129	129	123	129	123
1 1/16	C.S.	129	135	135	129	135	129
1 1/16	H.S.S.	129	135	135	129	135	129
1 1/16	C.S.	135	141	141	135	141	135
1 1/16	H.S.S.	135	141	141	135	141	135
1 1/16	C.S.	141	147	147	141	147	141
1 1/16	H.S.S.	141	147	147	141	147	141
1 1/16	C.S.	147	153	153	147	153	147
1 1/16	H.S.S.	147	153	153	147	153	147
1 1/16	C.S.	153	159	159	153	159	153
1 1/16	H.S.S.	153	159	159	153	159	153
1 1/16	C.S.	159	165	165	159	165	159
1 1/16	H.S.S.	159	165	165	159	165	159
1 1/16	C.S.	165	171	171	165	171	165
1 1/16	H.S.S.	165	171	171	165	171	165
1 1/16	C.S.	171	177	177	171	177	171
1 1/16	H.S.S.	171	177	177	171	177	171
1 1/16	C.S.	177	183	183	177	183	177
1 1/16	H.S.S.	177	183	183	177	183	177
1 1/16	C.S.	183	189	189	183	189	183
1 1/16	H.S.S.	183	189	189	183	189	183
1 1/16	C.S.	189	195	195	189	195	189
1 1/16	H.S.S.	189	195	195	189	195	189
1 1/16	C.S.	195	201	201	195	201	195
1 1/16	H.S.S.	195	201	201	195	201	195
1 1/16	C.S.	201	207	207	201	207	201
1 1/16	H.S.S.	201	207	207	201	207	201
1 1/16	C.S.	207	213	213	207	213	207
1 1/16	H.S.S.	207	213	213	207	213	207
1 1/16	C.S.	213	219	219	213	219	213
1 1/16	H.S.S.	213	219	219	213	219	213
1 1/16	C.S.	219	225	225	219	225	219
1 1/16	H.S.S.	219	225	225	219	225	219
1 1/16	C.S.	225	231	231	225	231	225
1 1/16	H.S.S.	225	231	231	225	231	225
1 1/16	C.S.	231	237	237	231	237	231
1 1/16	H.S.S.	231	237	237	231	237	231
1 1/16	C.S.	237	243	243	237	243	237
1 1/16	H.S.S.	237	243	243	237	243	237
1 1/16	C.S.	243	249	249	243	249	243
1 1/16	H.S.S.	243	249	249	243	249	243
1 1/16	C.S.	249	255	255	249	255	249
1 1/16	H.S.S.	249	255	255	249	255	249
1 1/16	C.S.	255	261	261	255	261	255
1 1/16	H.S.S.	255	261	261	255	261	255
1 1/16	C.S.	261	267	267	261	267	261
1 1/16	H.S.S.	261	267	267	261	267	261
1 1/16	C.S.	267	273	273	267	273	267
1 1/16	H.S.S.	267	273	273	267	273	267
1 1/16	C.S.	273	279	279	273	279	273
1 1/16	H.S.S.	273	279	279	273	279	273
1 1/16	C.S.	279	285	285	279	285	279
1 1/16	H.S.S.	279	285	285	279	285	279
1 1/16	C.S.	285	291	291	285	291	285
1 1/16	H.S.S.	285	291	291	285	291	285
1 1/16	C.S.	291	297	297	291	297	291
1 1/16	H.S.S.	291	297	297	291	297	291
1 1/16	C.S.	297	303	303	297	303	297
1 1/16	H.S.S.	297	303	303	297	303	297
1 1/16	C.S.	303	309	309	303	309	303
1 1/16	H.S.S.	303	309	309	303	309	303
1 1/16	C.S.	309	315	315	309	315	309
1 1/16	H.S.S.	309	315	315	309	315	309

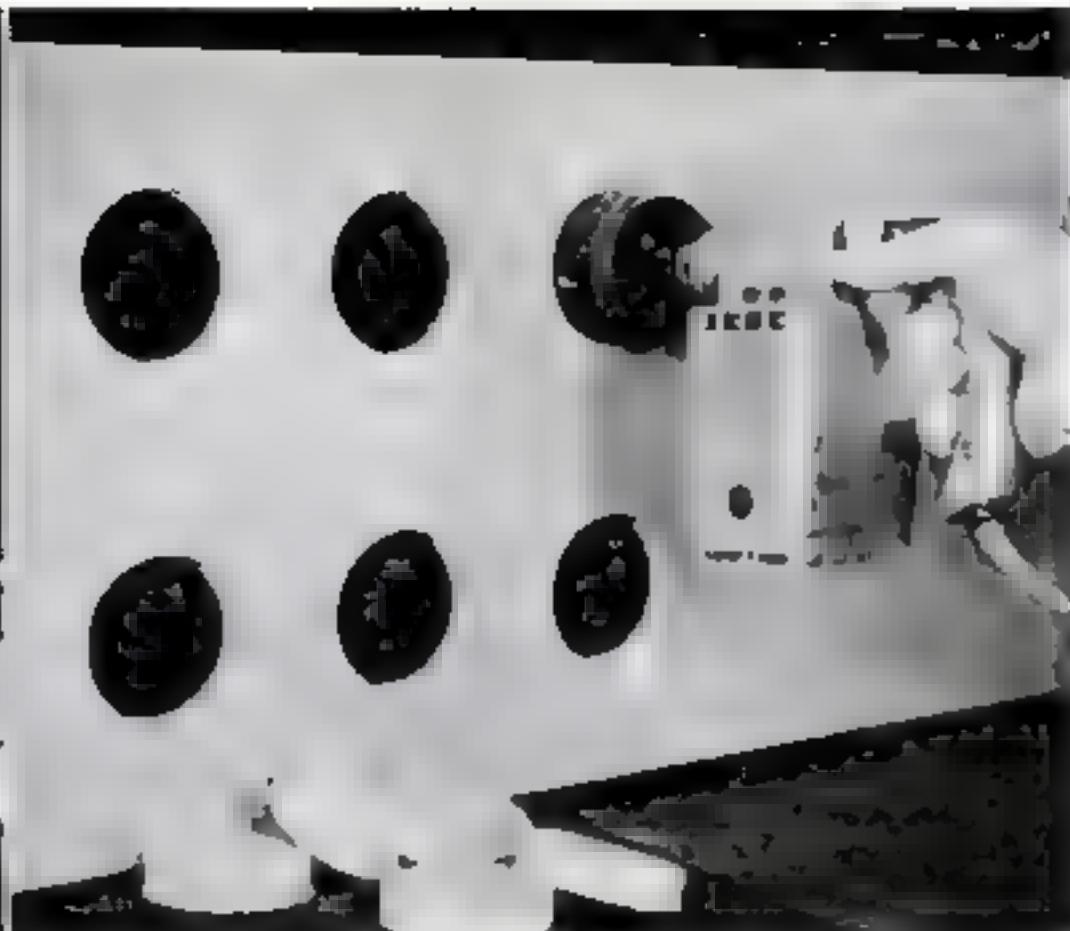


For fast drilling in light materials, you run the motor up to full speed. If you hit a knot, you can throttle down by simply flicking the knob with your thumb—with the drill running.

carbide-tipped bit, mixing paint so it doesn't whip out of the can. The new Disston Dial-A-Power drill did all these jobs and others—including making 3" holes in $\frac{1}{2}$ " hardboard-surfaced plywood with a hole saw.

The range of work would normally have required two or three different drills, and even then any particular speed would have been a compromise.

Dialing the speed. Setting the speed is a cinch. Glance at the chart on the top of the drill to find your correct speed, and turn the small, numbered knob at the side. You can choose any speed between 600 and 2,000 r.p.m.—and at any setting you select you get the full power of the $\frac{1}{2}$ -hp. motor.



Large holes like these three-inchers are a tough job for any drill, but proved to be no problem for the Dial-A-Power. Even deliberately forcing the feed failed to stall the drill.

You can change speeds regardless of whether the drill is shut off, running free, or under load. That last possibility proved especially impressive when I had to get through a particularly knotty area in a piece of wood. It was like shifting a car into low gear halfway up a steep hill.

But this drill doesn't use gears. Gears couldn't give you those infinitely variable speeds; and besides, it's doubtful if you could squeeze them into the case, which is the size of a standard $\frac{1}{2}$ " drill.

The secret behind the Disston drill's variable speeds is a silicon-controlled rectifier—the miracle device that will surely end up revolutionizing the workshop by adapting the speed of many machines to the work.

How electronic speed control works

The concept is based on the use of solid-state electronic circuitry with what is known as "feedback." The principle is not new in electronics, but using it in a portable electric tool is an imaginative and highly successful application.

The feedback circuit is like an electronic brain that manipulates drill power according to the load at the cutting end. Its heart is a silicon-controlled rectifier. Turning the small control knob to select a speed adjusts a variable resistor that decides the value of the bias voltage on the

controlled rectifier. In turn, this controls the amount of current that can pass through the motor's armature.

Drill power is produced by rectifying the AC house current in a solid-state rectifier bridge network to provide a pulsating DC voltage. When this pulsating voltage is at zero, which occurs at the end of every half-cycle, the armature's motion generates a small voltage of its own—feedback. This is returned through a transistor to the controlled rectifier.

When the drill speed is constant (a no-load condition), the feedback voltage remains constant. When the drill slows down

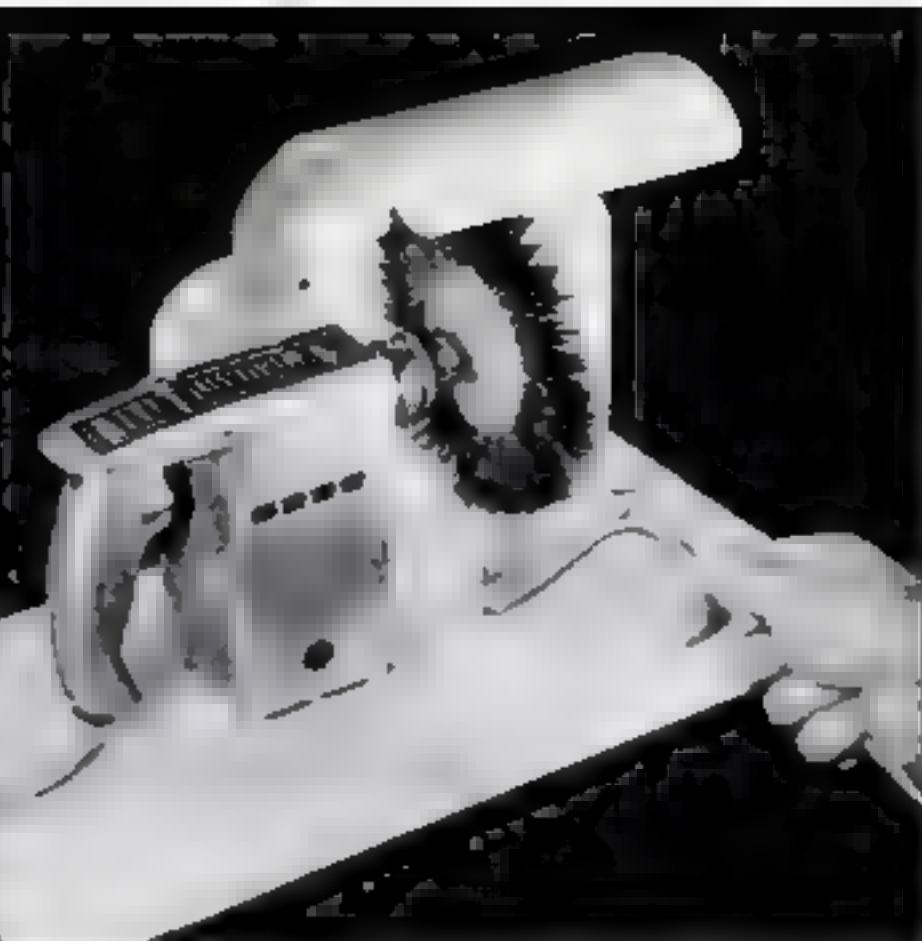


Clean holes in plastic, difficult with a fixed-speed drill, are made possible by slowing down the Disston. This eliminates overheating that melts the plastic, gums up drill bits.

Protection from burn-out. Another fine feature is a thermostat that provides overheat protection by shutting off power if the drill gets too hot. When it cools off, it's ready to go to work again. This is one drill you can't burn out.

In shape and size, the new drill almost duplicates the $\frac{1}{2}$ " drill with which Disston made its debut in the portable-drill field a year ago. There are the same stand-up base, offset motor, on-or-off blower, slim profile, and short overall length that lets you get between studs and into other tight places.

Made by the Disston Division of H. K. Porter Co., Pittsburgh, the $\frac{1}{2}$ " Dial-A-Power drill sells for \$89.96. The electronic circuit is guaranteed for a year. ■ ■



Stand-up base makes the drill ideal for use with accessories. It can be bolted to a wood stand by replacing short screws in the base plate with long ones that go through the wood.

The new DISSTON DRILL at a glance

Speed: 600-2,000 r.p.m.

Chuck capacity: $\frac{1}{2}$ "

Amps: 4.1

Power: $\frac{1}{2}$ hp.

Weight: 4 pounds

Overall length: $7\frac{1}{2}$ "

Price: \$89.65

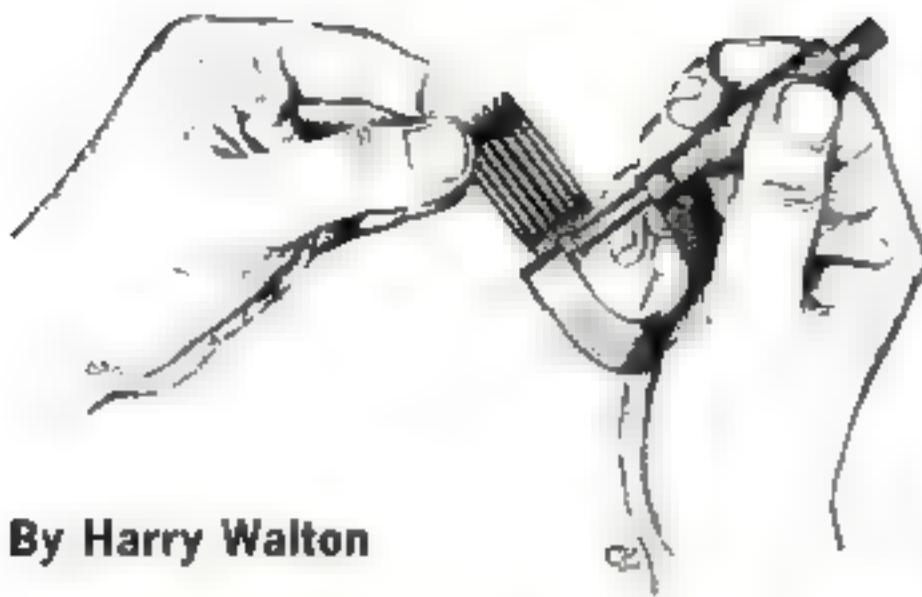
(a load condition), the feedback becomes smaller and changes the value of the bias on the controlled rectifier. This increases the amount of current fed to the motor, speeding up the drill. The action is practically instantaneous so that drill speed remains constant no matter what the load.

Actually, this is somewhat similar to a household thermostat that, sensing a drop in temperature, automatically decides more heat is needed. By varying the bias voltage with the control knob, you can set the drill to run at any desired speed—just as you would set a thermostat to provide a desired temperature. Thereafter, the auto-

matic action of the feedback voltage keeps the drill running at that preset speed regardless of load.

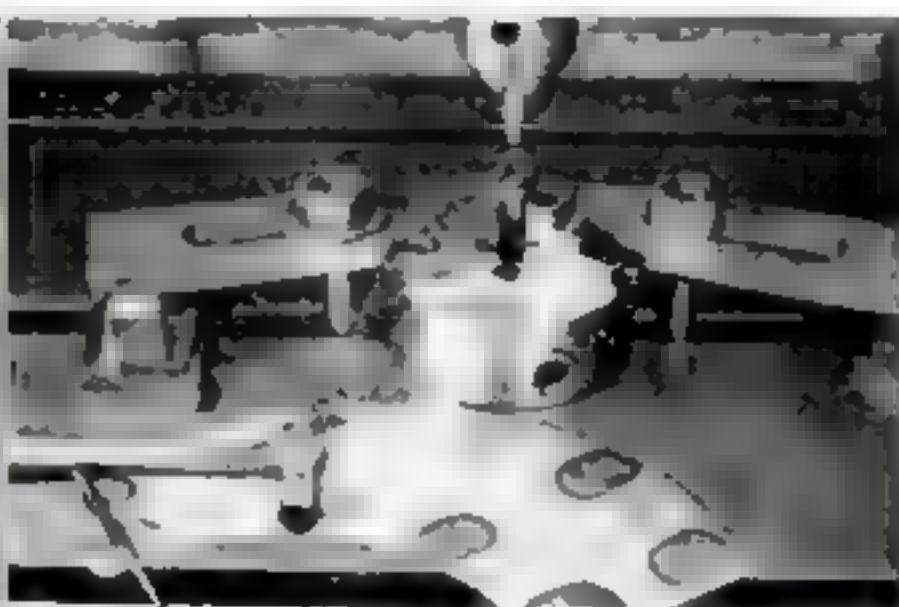
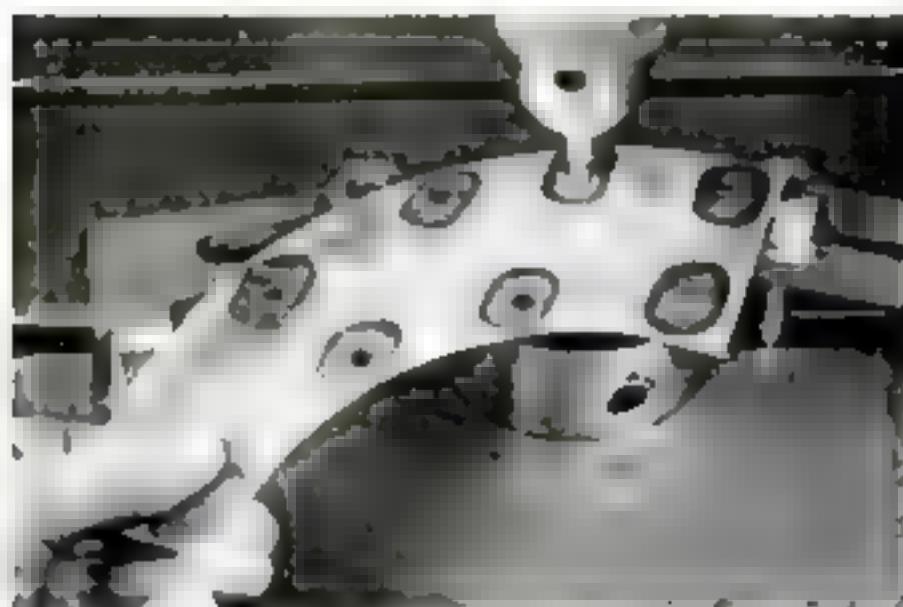
The components are strategically located to get maximum benefit from the forced-draft cooling system and have their own cooling fins. A thermostat will break off contact under particularly harsh drilling conditions, thus guarding against burn-out. To make the drill operative again, you merely press a reset button.

The circuit was developed in conjunction with Texas Instruments, Inc., whose products can be found in items ranging from vest-pocket radios to satellites.



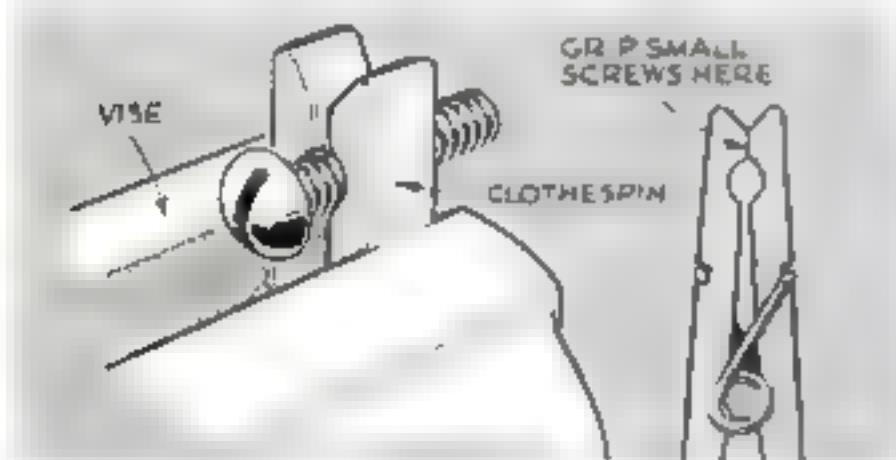
By Harry Walton

Between Us Machinists

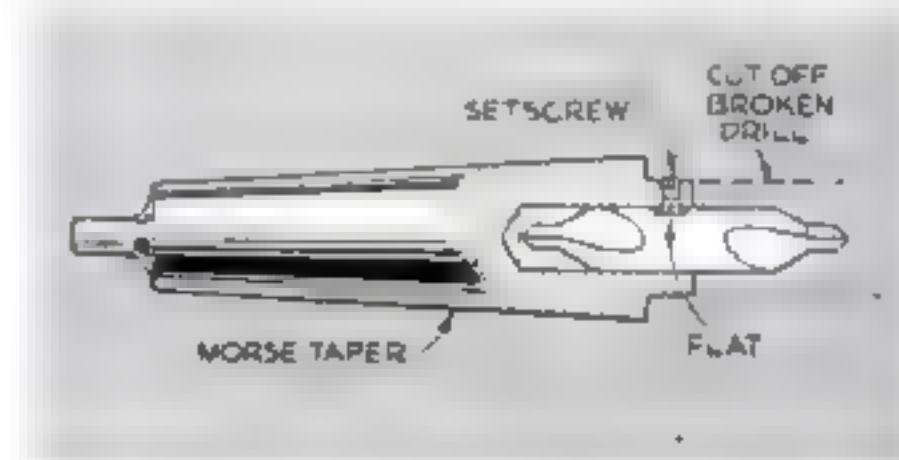


For cleaner holes in sheet metal, says H. J. Gerber of Menomonie, Wis., use your drill press to punch them out instead of drilling. It's not only cleaner but also faster than drilling, especially on repeat work. Make punches of drill rod, long enough to bottom in the drill chuck. Face the end square, leaving a small center nib to engage cen-

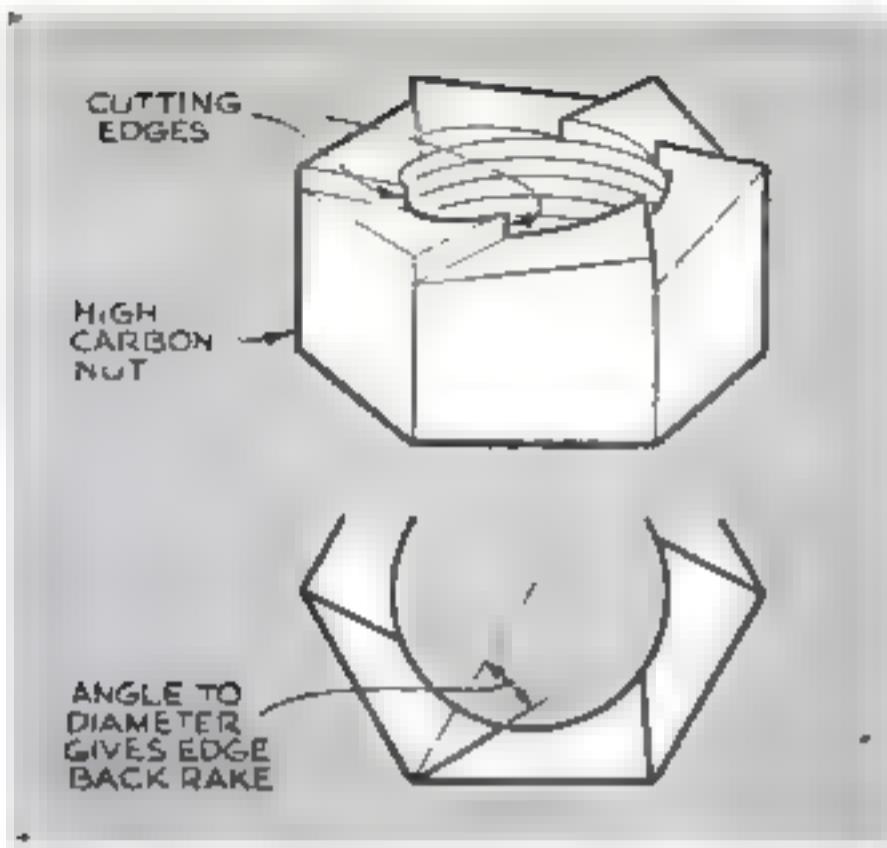
ter-punched layout dimples on the work. Drill the dies to a close sliding fit. Harden both parts. The dies can be held in a lathe chuck clamped to the drill-press table as above, or in a plain steel block. A shoulder turned on the dies to take working thrust will make it unnecessary for you to tighten the chuck excessively.



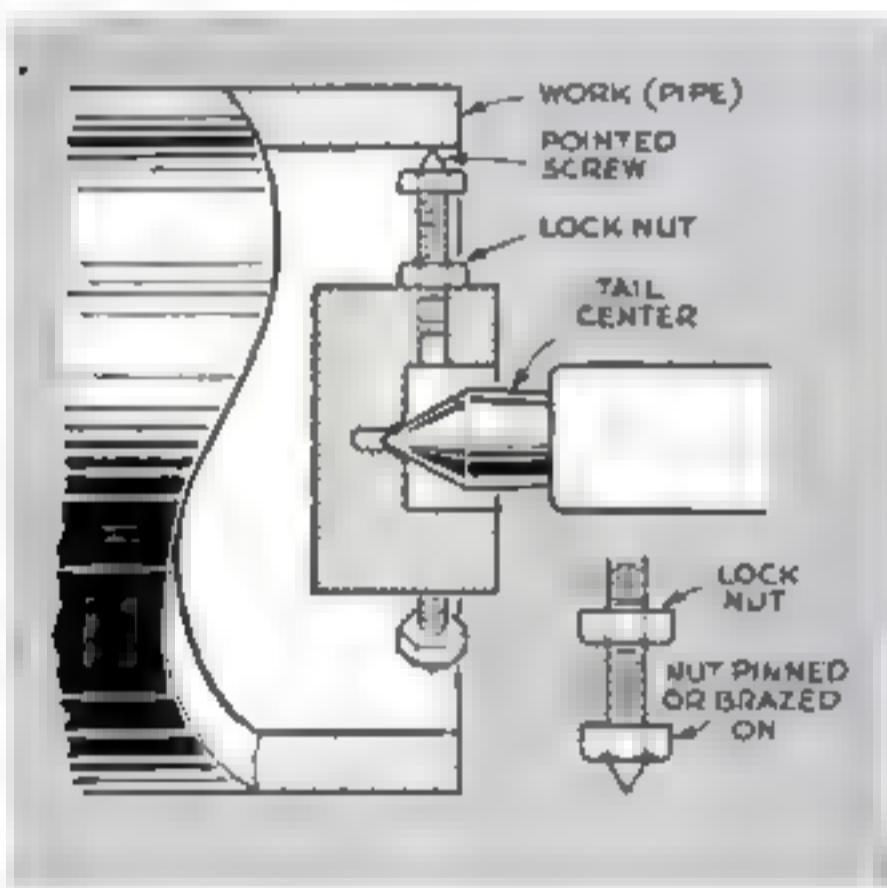
Spare the threads and you save the bolt. That's why I keep a wooden spring clothespin around for use if I have to saw a bolt shorter. I pinch the bolt shank in the clothespin and clamp the pin in a vise. The wooden jaws don't harm even brass screws. Little ones such as 2-56s are less likely to be fumbled and lost this way than if you put them directly in a large vise. If too small to grip in the notch of the clothespin jaws, they can be held between the flats above the notch.



Centerdrills in taper shanks save much time in the shop where he is a trainee, reports James W. Hauser of Racine, Wis. Lathe operators find it's much quicker to pick up one of these and slip it into the tailstock than to first mount a chuck and then lock a centerdrill in it. Shanks are salvaged from broken taper-shank drills. Cut off the stub, leaving enough shoulder to tap for a setscrew. Face the end, drill to suit, and grind a little flat on the centerdrill for the setscrew.



When a stud was damaged on his car, Fred F. Davis of Vancouver, British Columbia, restored the marred threads with a chaser made of a high-carbon nut of the same size. On one face of this he ground and filed a slope adjacent to each wrench flat, so forming six edges like those of a die. Their rake angle made them effective. The chaser is turned on edged face first.



A big adjustable center for mounting pipe in a lathe can be made from a small scrap of round stock. In a $1\frac{1}{2}$ " length of 2" bar, suggests Federico Strasser of Santiago, Chile, bore a $\frac{1}{2}$ " hole $\frac{1}{2}$ " deep. Centerdrill the inner face. Drill and tap three radial holes 120 degrees apart in the edge. Turn points on three screws, and pin or braze nuts near the points. Mount pipe to run true by adjusting the screws inside it, turning them by the brazed nuts. Tighten lock nuts to hold them.



Motorless mower is a handy dolly

Removal of the motor from an old power lawn mower converted it into a convenient dolly for moving heavy loads around my home and shop. The top of the blade guard is ideal for such items as the barrel being carried above. The four rubber tires make the dolly easy to roll on any surface.—Wayne Floyd, Fayetteville, Tenn.



Use light meter for radio tuning

When tuning the transmitter of a citizen's-band or ham radio to a dummy-load light bulb, use a light meter instead of looking at the light itself.

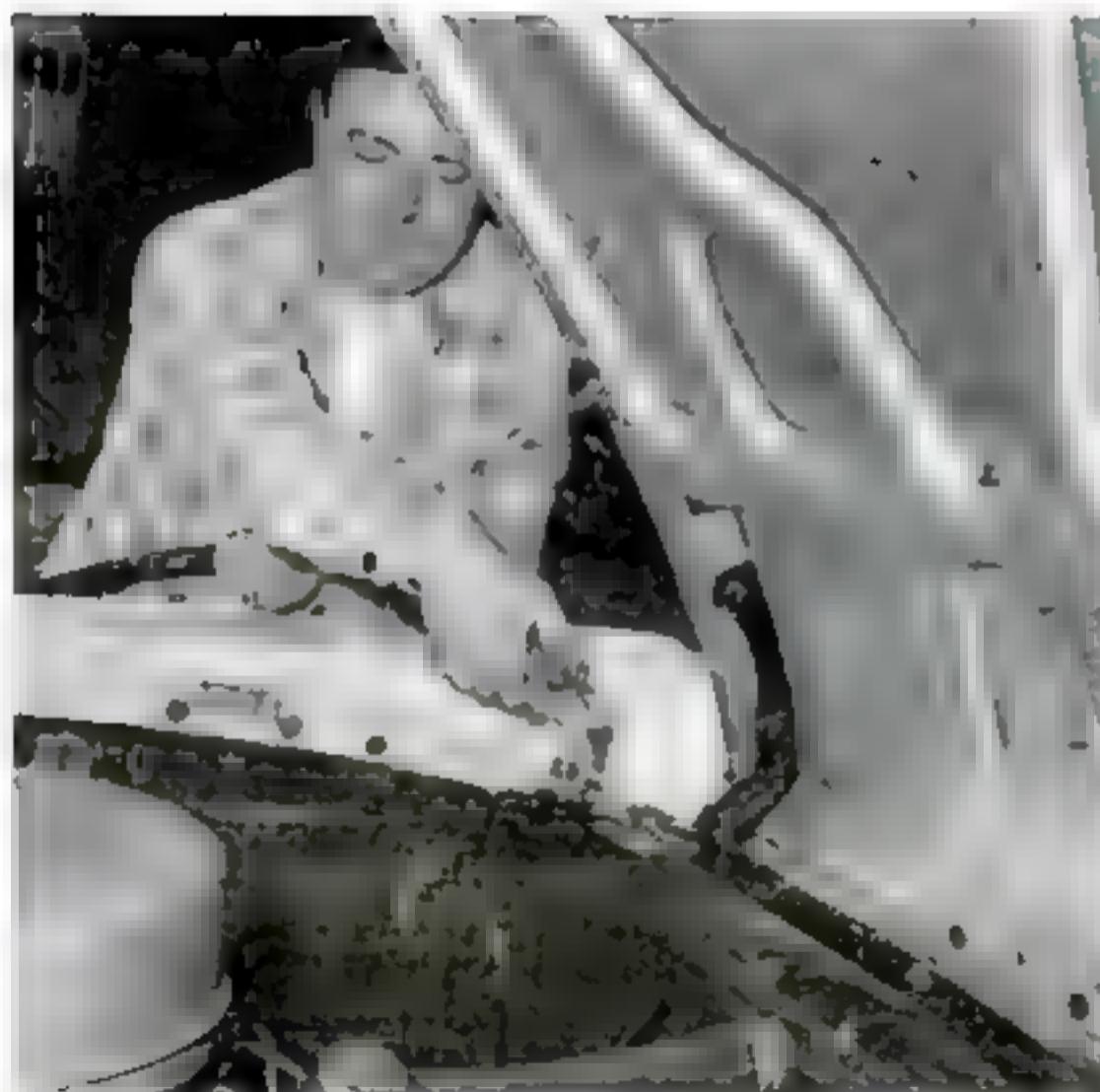
You won't be blinded by the light since it can be behind the set. The degree of brilliance can be noted on the meter and comparisons made. You can use any light meter; adjust the distance from the bulb until the meter shows about a half-scale reading. Distance from bulb to meter is not important, but the distance and the angle of the meter should be kept uniform when comparing sets or components.—R. A. Brown, Shelbyville, Tenn.

SPRING CAR CARE

Do it now—don't wait till summer

By Herbert R.
Pfister

THE best insurance against having your car conk out on some sun-scorched day this summer is to go over it carefully this spring. You'll be surprised at how much you can do in your own driveway or garage on a Saturday morning. What do you need? Not much more than a screwdriver, a few wrenches, a bit of confidence, and these tips from Popular Science.



Draining and refilling the cooling system is a spring requirement unless you use an all-season coolant. It's simple to do this at home. Look for drain cocks on one side of a four- or six-cylinder engine block, on both sides of an eight. Turn them counterclockwise to drain the system.

COOLING SYSTEM

MANY things can cause engine overheating—underinflated tires, for example—but a neglected cooling system is the most common villain. Unless you use an all-year coolant, drain the cooling system completely. Refill with clean water and rust inhibitor.

If hose connections are cracked or feel limp when you squeeze them, replace them now before they rupture.

Adjust the fan belt so that it gives about $\frac{1}{2}$ " when you apply thumb pressure halfway between fan and generator pulleys. Adjust by loosening the generator and pivoting it outwards. Be sure to tighten the pivot bolts securely. Replace the belt if it's frayed or cracked; a worn belt racing around pulleys can set up vibrations that travel through the car.

FUEL SYSTEM

YOUR fuel system's worst enemy is dirt: dust, sediment, gum. Begin by cleaning the air filter on top of the carburetor. Tap the filter sharply to dislodge dirt, and wipe the housing clean with a dry cloth.

Wash the oil-filler cap and fuel-pump bowl with kerosene or lacquer thinner.

Follow the fuel line back from the pump and bend it away from the engine or exhaust manifold; close proximity to any hot spot can cause fuel in the line to boil. The resulting vapor lock will stall the car. Although vapor lock can happen anywhere, it is most frequent in mountain driving.

Clean the carburetor by adding a solvent (such as Wynn, Carbmaster, Marvel, Siloo, Gumout) to a tankful of gas, or by connecting a carburetor cleanout kit to the inlet fitting and running solvent through the unit by gravity flow.

No amount of carburetor tinkering will make your car run better—jets and metering rods are set at the factory—but you can make the engine idle smoothly and prevent embarrassing stalling by adjusting the idle speed and mixture, as shown in photos on this page. After adjusting the carb on a car equipped with an automatic transmission, make a final check by pulling up hard on the parking brake and shifting to Drive. If the idle speed slows to the point of stalling, give the hot-idle adjusting screw a half-turn or so to increase r.p.m.

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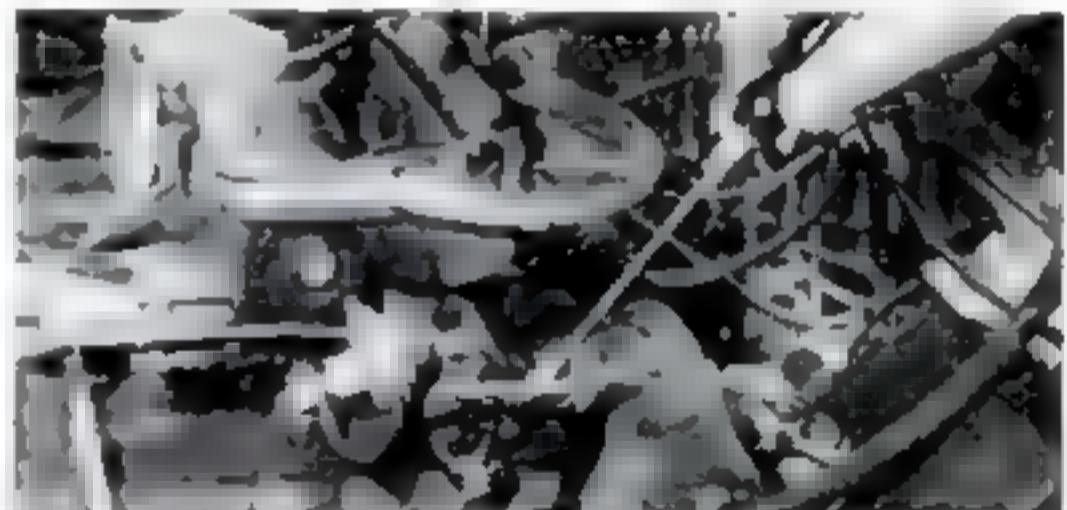
Manifold heat-control valve, which hastens warmup by diverting exhaust around intake manifold, can cause engine to run hot if stuck closed. Open, it encourages condensation by delaying warmup. To free it, squirt rust solvent or penetrating oil on shaft and jiggle arm up and down until it swings easily.



Begin carburetor adjustment with fast-idle adjustment—while the engine is cold and the choke closed. Adjusting screw bears against high point of stepped cam linked to the choke control. Note the position of the butterfly valve and linkage while the engine is cold.



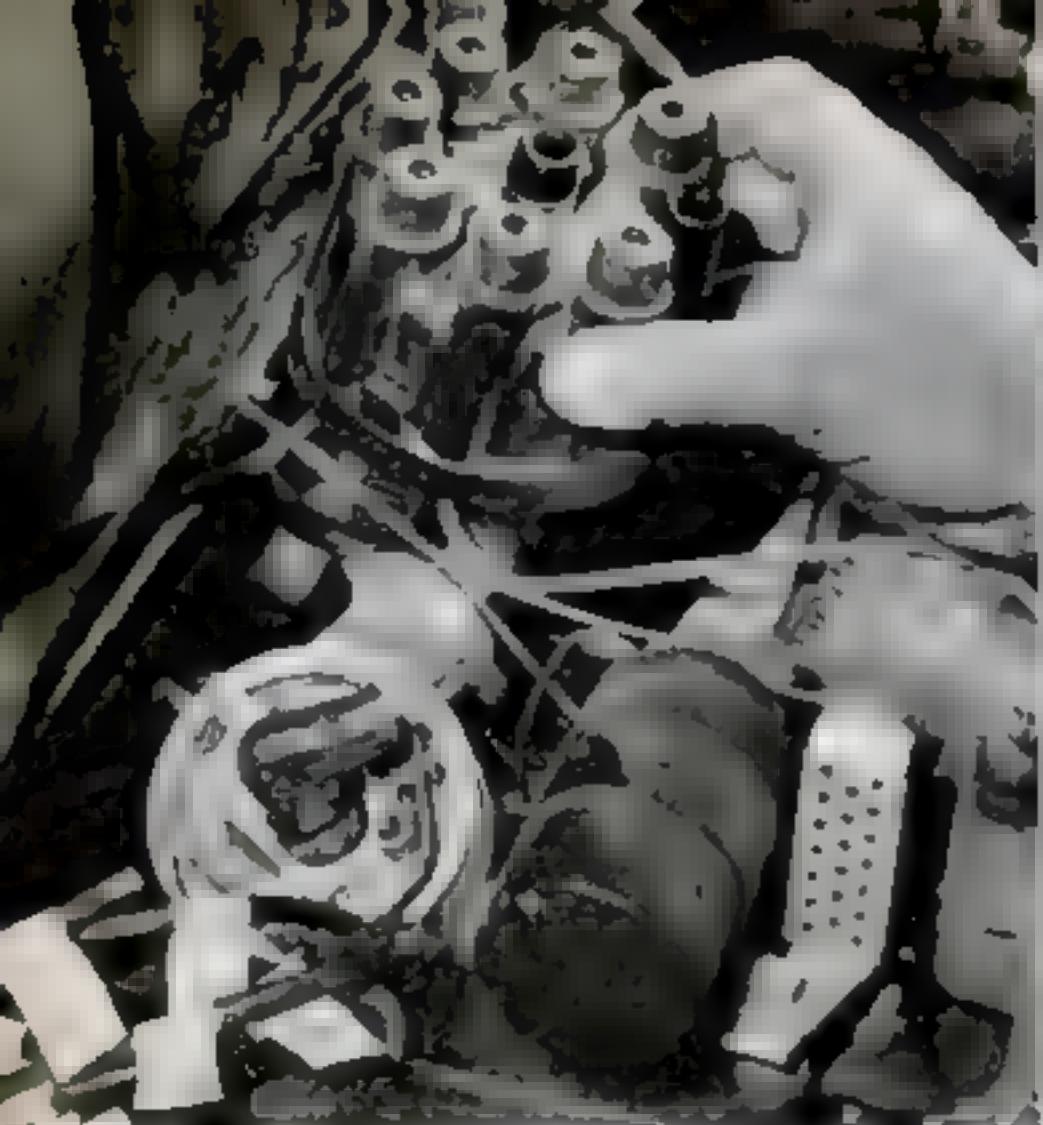
Choke and linkage look like this after engine warms. The butterfly valve has opened and the fast idle cam has moved, no longer holding throttle partly open.



Hot-idle adjustment, or normal setting, is made after engine warms. Adjusting screw, usually on opposite side of carb, is set for slowest reliable idle speed.

Mixture is made richer or leaner by turning adjusting screw (or screws) in until engine skips. Then back screw out until engine runs smoothly. If you have trouble doing this, it often helps to remove the adjusting screws and wash their pointed ends with lacquer thinner.





Distributor cap must be removed if you'd put new pep in the engine. No need to be timid about it; just snap off the chips on each side and lift the cap upward. Play safe by numbering wires before you remove them from cap.



Rotor works hard, rotating rev for rev with engine to fire all plugs each time around. Likely trouble spot is spring contact. Sand clean and bend it up slightly for better contact. Install a new rotor if you find severe pitting.

IGNITION SYSTEM

THE ignition system must produce a hot, fat spark at just the right time to ignite the fuel to push down on the pistons that turn the crankshaft to make your car go. As with any electrical equipment, simply keeping all contacts clean and bright goes a long way toward maintaining peak performance.

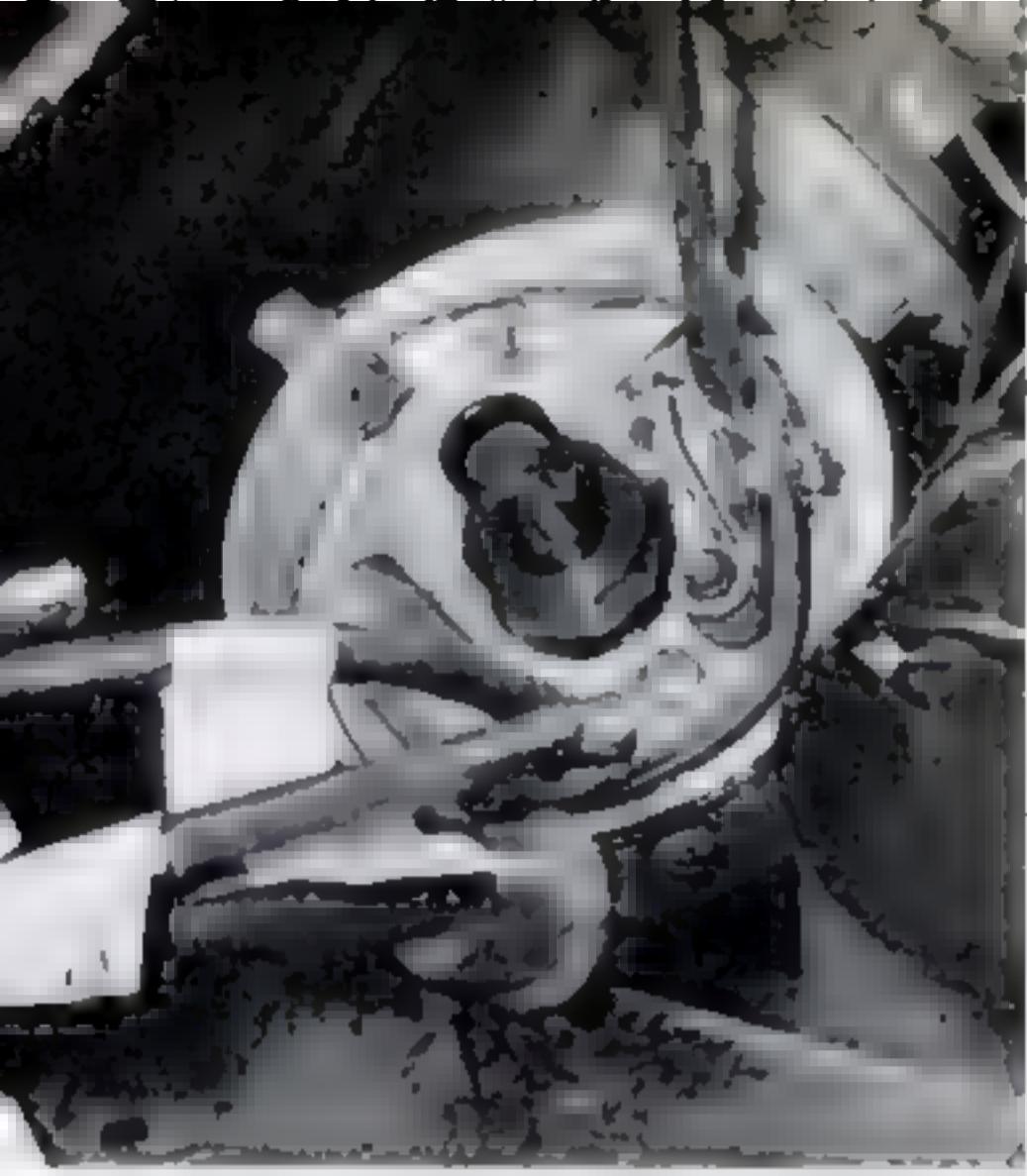
Start where the spark occurs by removing the spark plugs. If they're only dirty and the electrodes aren't burned thin, soak them in a pan of lacquer thinner—not benzine, kerosene, or alcohol—while you check the high-tension wires from the distributor and use a kit to replace them if they're cracked or oil-softened. After soaking the plugs about 10 minutes, scrape around the insulators with a large needle to flake off the softened carbon. Set the plug gap by bending the outer electrode up or down until its lower edge is separated from the center electrode by the proper gap, using a feeler gauge. If you've no manual, your gas dealer can tell you the correct settings for plugs, points, and ignition timing. Write these specs on a small card and tape them to the firewall for permanent reference.

Write numbers on masking tape and stick them on the plug wires before you yank them out of the distributor cap. This way, you'll be certain to reinsert them in the proper terminal sockets. As you pull each wire, inspect the metal contact on its end. If it's dirty or green with corrosion, sand it bright and check the matching socket in the distributor cap. Black powder in the socket indicates an arcing condition, and a new cap is recommended. A sound cap can be cleaned with lacquer thinner and wiped dry. Twist a thin wad of steel wool in the sockets to brighten terminals.

Pull straight up on the rotor to remove it from the distributor shaft. Brighten the spring contact and the tip of the rotor with fine sandpaper and wipe the part clean with a dry cloth.

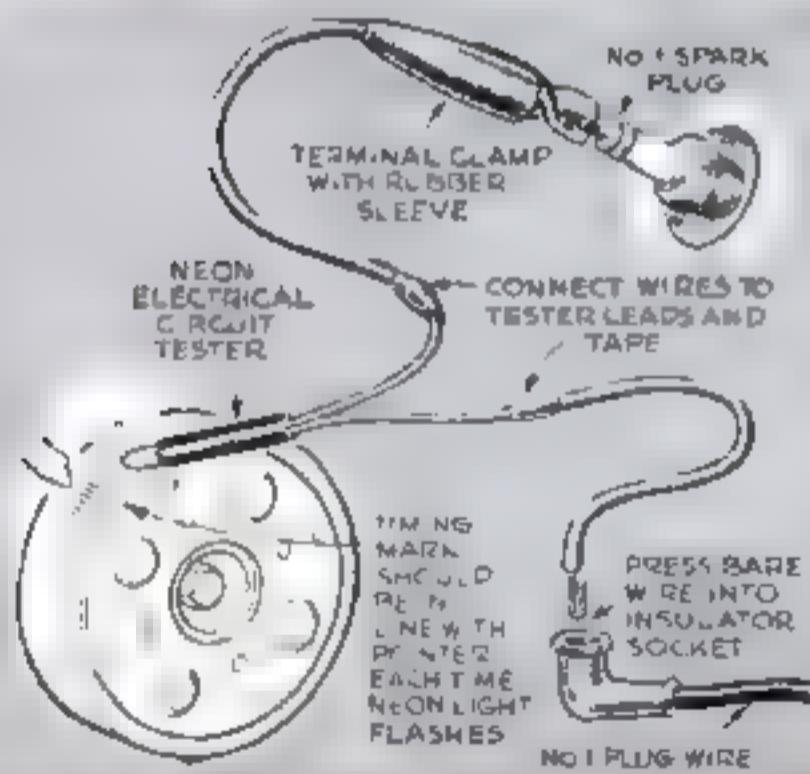
On most GM cars, the points can be adjusted from outside the distributor while the engine is running. Insert an Allen wrench in a hole in the side of the cap and turn it slowly until the engine skips. Then back off a half-turn for a basic setting.

Adjusting the point gap changes the ignition timing very slightly—usually not enough to require retiming. But for top performance, check the timing as shown on facing page.



Ignition points close and open just before each spark is generated. Press the movable arm outward to inspect contact faces. If they're pitted or sooty, put in new points. Otherwise, check and set the point gap. Crank the engine until the little fiber block rests on one of the high spots of the cam. Loosen the adjusting screw and move the stationary arm against a feeler gauge placed between the points. Tighten the screw and recheck the point gap.

How to make a 59-cent timing light—and use it



Timing light can be made from a neon circuit tester costing 59 cents in any hardware store. Tape tester to a dowel so you can place it close to the timing mark on the flywheel. Work in the shade so dim light of neon tube will illuminate the chalk-brightened timing mark. Leads are connected to No. 1 spark plug and wire. Disconnect the vacuum line at the distributor



and hold the timing light close to the pointer while the engine idles. If timing mark doesn't line up with pointer as shown, loosen lock nut beneath distributor and rotate the unit very slightly to advance or retard the timing until strobe effect of neon tube shows mark at correct setting. Tighten the nut under the distributor and reconnect vacuum line when job is done.

CONTINUED

BRAKES

IF THE pedal feels low, or if you must pump it to build up braking effort, it's probably time for some brake work. It's a good idea to pull the front brake drums (or have it done) and clean the wheel bearings in kerosene. Wipe them dry with a *clean* cloth and repack by pressing fibrous wheel-bearing grease between the rollers. While the drums are off, check the brake lining. If it's worn flush with the rivets, or if there are coarse grooves on the lining and drums, it's high time to reline the shoes on all four wheels.

When putting drums back, tighten the castellated nut until the drum binds when rotated. Then back off the nut until the slots line up with the cotter-pin hole in the spindle. Use new cotter pins, and insert them from above. Bend the legs around the nut.



Check brake fluid in the master cylinder. It should be about $\frac{1}{2}$ " from the top.

BODY CARE

Hose off the underbody to get rid of corrosive salts thrown up from winter highways. You can do this by taping the hose and shower head to a rake or other long-handled tool and pushing the head under the car. If possible, connect the hose to the hot-water faucet in the basement utility sink. The hot water will do a better cleaning job than cold.

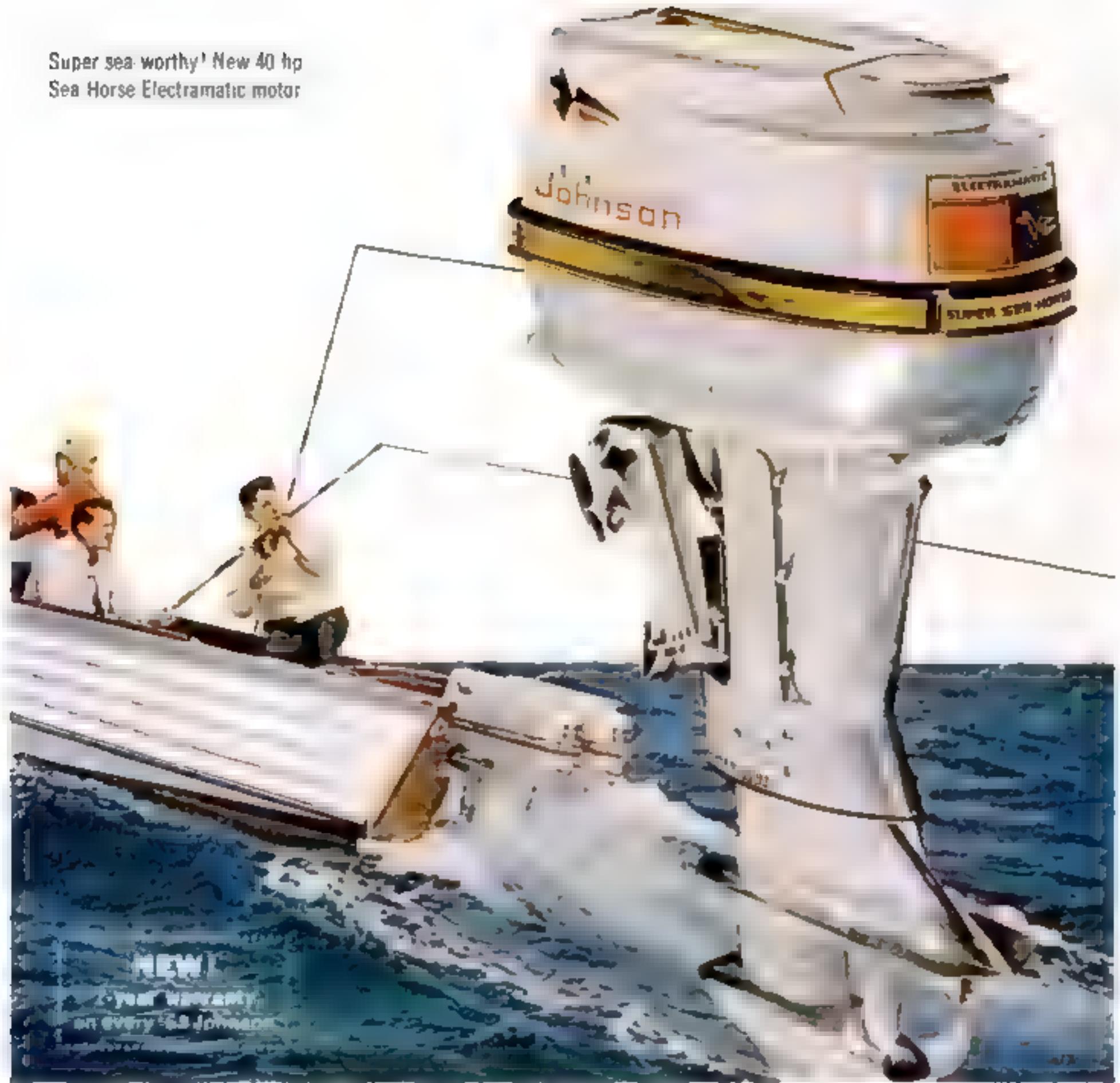


Tail lights rust out fast when highway salts pack into and around them, as you see in this photo. So it'll pay you to remove yours and check their condition while there's time.



Paint touchup takes only a few minutes. Matching colors for all cars are available in spray cans. Complete job by cleaning and waxing finish to protect it from the hot summer sun. ■ ■

Super sea-worthy! New 40 hp
Sea Horse Electramatic motor



Built to boss big water!

Most responsive outboard ever built! Touch one lever—everything's "go"!

Move the directional throttle forward. Your clutch engages automatically, electrically—in a split second. Simultaneously your engine accelerates. Johnson's exclusive Electramatic Drive gives you the fastest gears and gas control—the quickest response in all outboating. And the king-sized cubic inch displacement ensures both effortless power and a long, happy engine life. See all ten new Sea Horse classics—from 3 to 75 hp—at your Johnson dealer's now. He's listed in the Yellow Pages. For free catalog, write Johnson Motors, 1348 Pershing Rd., Waukegan, Ill., Div. of Outboard Marine Corp.

JOHNSON First in Dependability



Exclusive Electramatic Drive

Outboating's first truly automatic transmission. Unique directional, throttle (comes with motor at no extra charge) controls both gas and gears. Makes driving sure, docking easy. At 40 and 75 hp.



FUN FIRST CLASS—a roomy camper body on a rugged Ford pickup! Ask your Ford Dealer!

Solid comfort—solid truck!

Slip into Ford's new Custom Cab and you'll find evidence of solid comfort everywhere. Doors open wide with no knee-knocking "dog-leg." A handy step helps you up and in. New foam seat cushioning is five inches deep; visibility is unmatched; over 23 pounds of insulation give you a quiet, relaxing ride.

But beneath this easy comfort lies solid truck . . . with big-truck toughness from axle to axle. See your Ford Dealer and see how painless buying a Ford can be . . . and how pleasant one is to drive!



BUILT LIKE THE BIG ONES. Wherever toughness counts—in axles, frame, springs—'63 Ford pickups give you extra freedom from costly breakdowns: the same kind of durable design as big trucks. Result: pickups that stay on the job and keep costs down over their long, long life!

PRODUCTS OF



MOTOR COMPANY

FORD TRUCKS

For
Outstanding
Reliability &
Durability

INSTANT PAVING: use it the day you lay it

A RESIN you mix with sand only and trowel on like concrete dries to a hard, tough surface in hours. Unlike cement, you need no gravel foundation; just tamp the dry soil firmly and lay on a $\frac{1}{2}$ " coating. The makers say it will be as strong as concrete five times as thick.

Armor-Cote Instant Patio Builder is a composition of polyethylene and urethane for driveways, walks, and the like. Five gallons will build a 10'-by-10' patio. Delka Research Corp., Hawthorne, N. J., sells it for \$9.95 a gallon.

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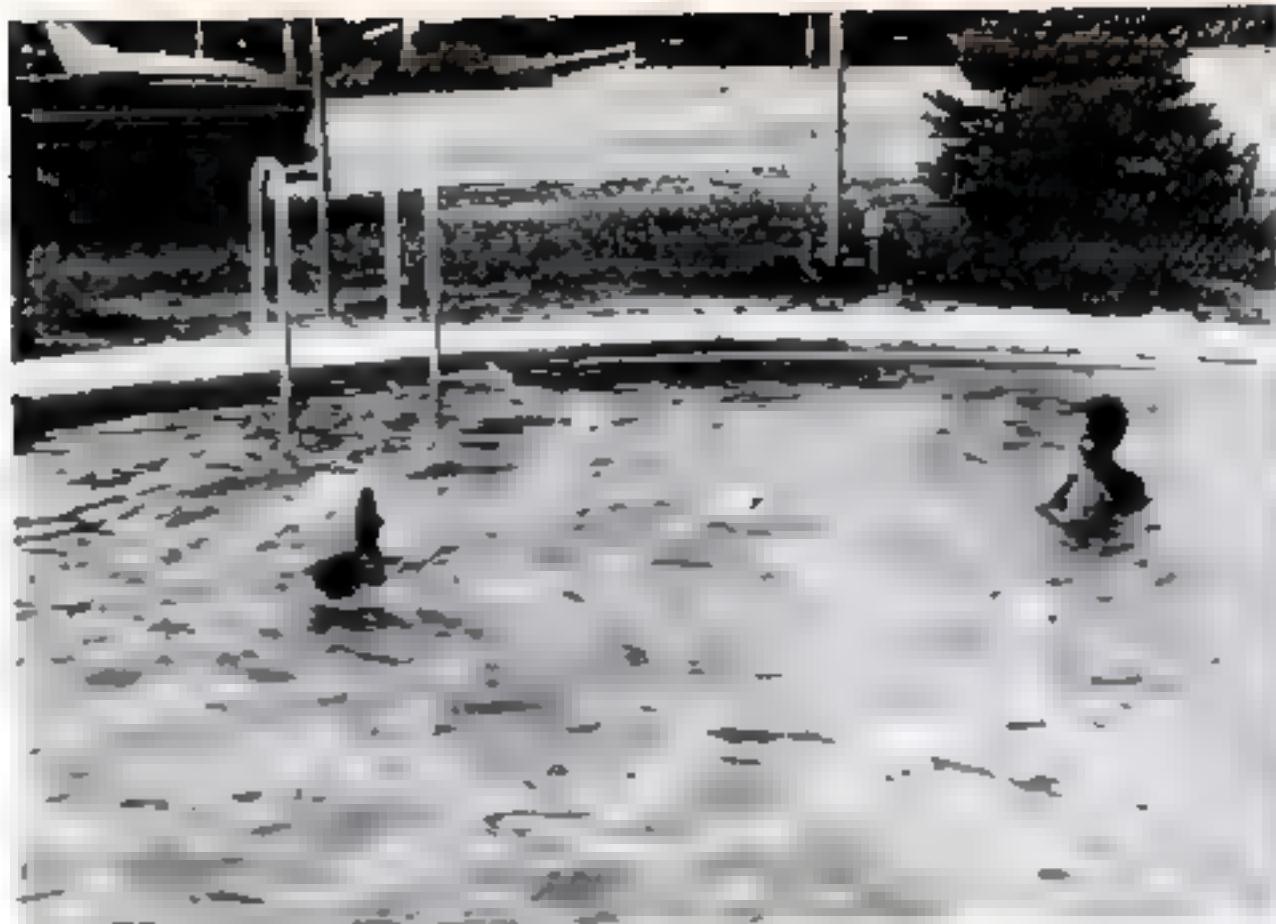
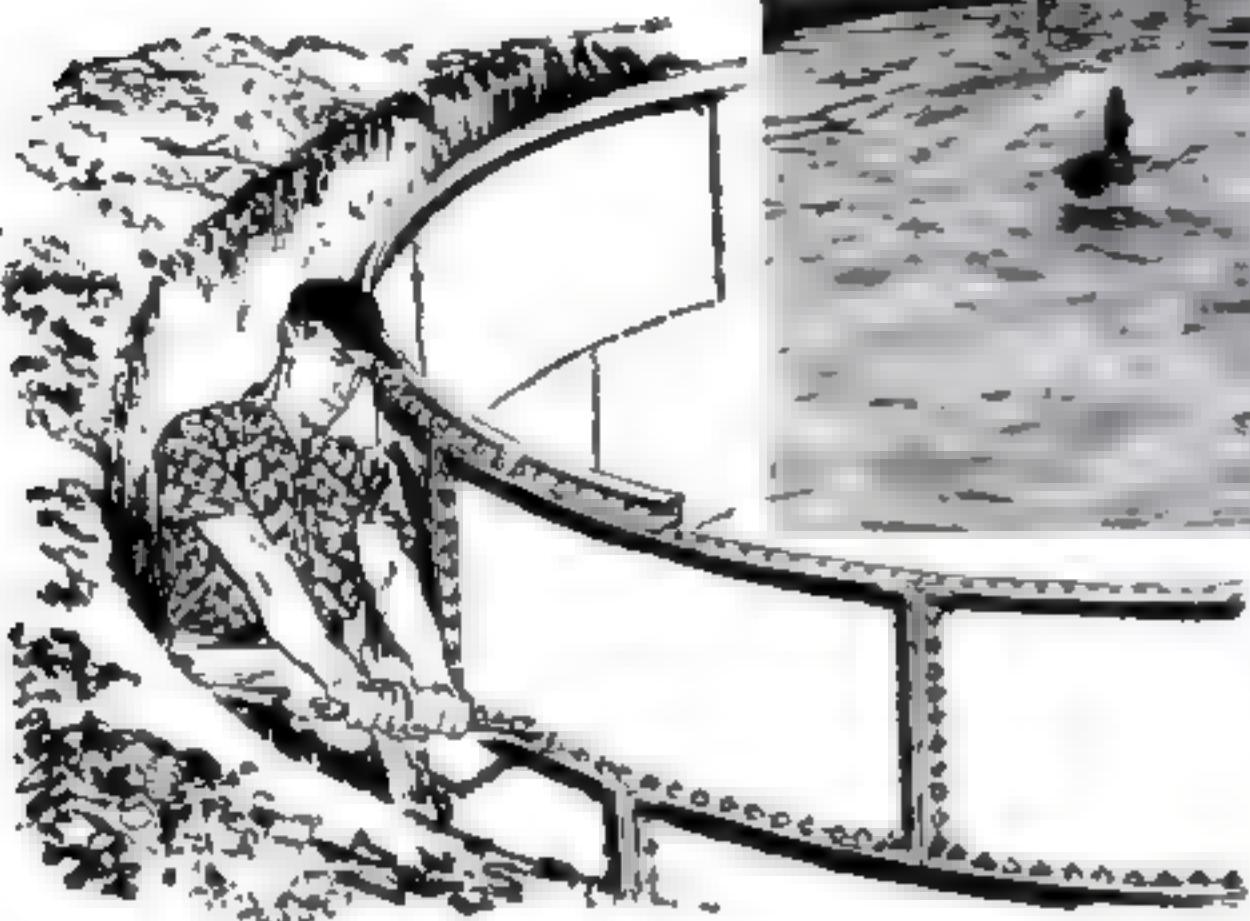
Just tamp soil firmly to provide dry, level surface after removing sod. Apply mix of Patio Builder and sand, one part to five, and trowel to $\frac{1}{2}$ " thickness.

12 pages
of the
latest
ideas
for your
home
and
yard



what's new

for the HOME



To keep pool watertight, panels are caulked at seams; a steel footer channel and rubber water stop join walls to concrete floor. Backs of steel panels are covered with bituminous coating.

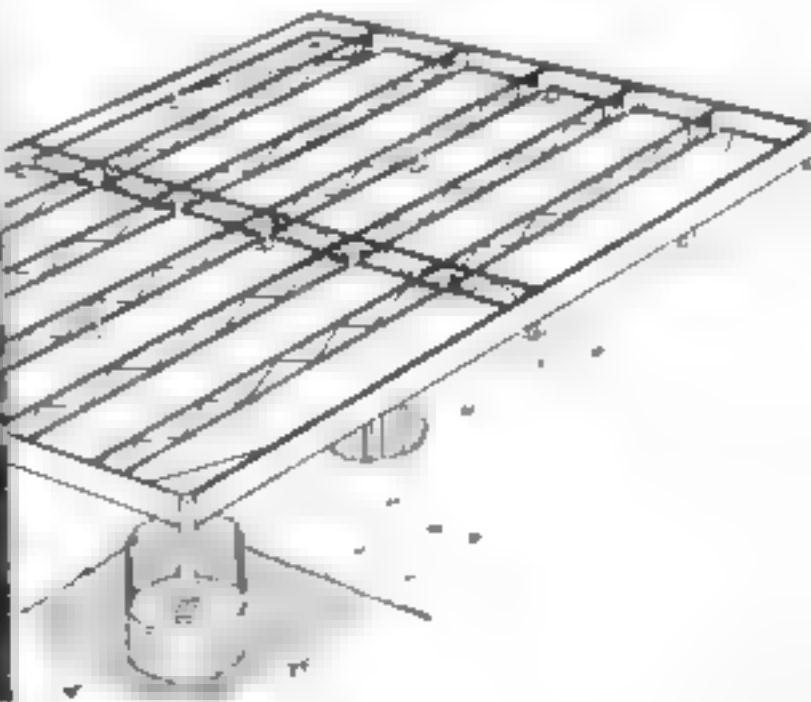
A Bolt-Together Steel Pool That Anyone Can Build

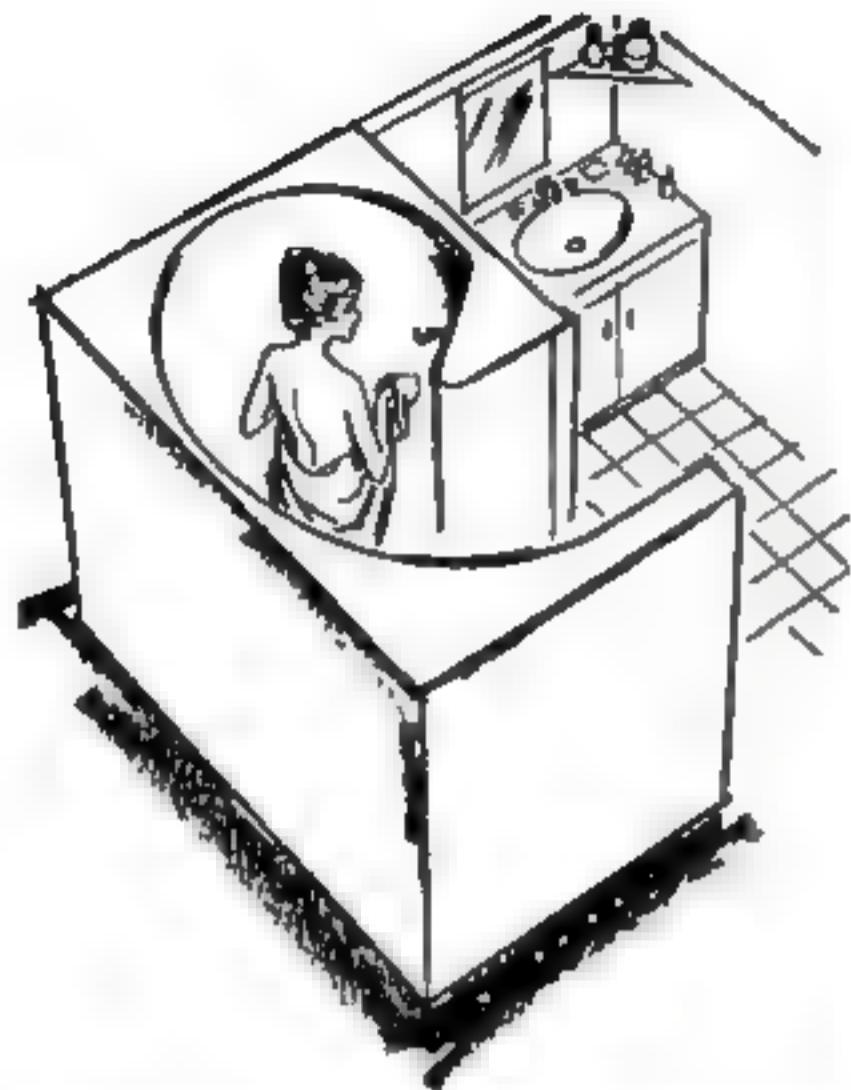
YOU buy only the walls of this pool—the part that's hardest to build. The floor and deck edging are conventional poured concrete. The walls are panels of porcelain-covered steel that simply bolt together and need no painting. Combining

straight and curved panels makes possible many shapes and sizes. A 15'-by-33' pool, completely installed with filter, sells for about \$3,000. But you can put the same pool in yourself for about \$1,800, says its maker, Clayton & Lambert, Buckner, Ky.

Steel foundation goes up in half a day

Tomorrow's homes may rest on steel stilts. A power auger digs a dozen holes, and steel-legged frames are simply dropped in—in as little as half a day. The method, devised by U. S. Steel, eliminates all concrete work except small footings below the frost line. Result: Builders aren't idled by bad weather.





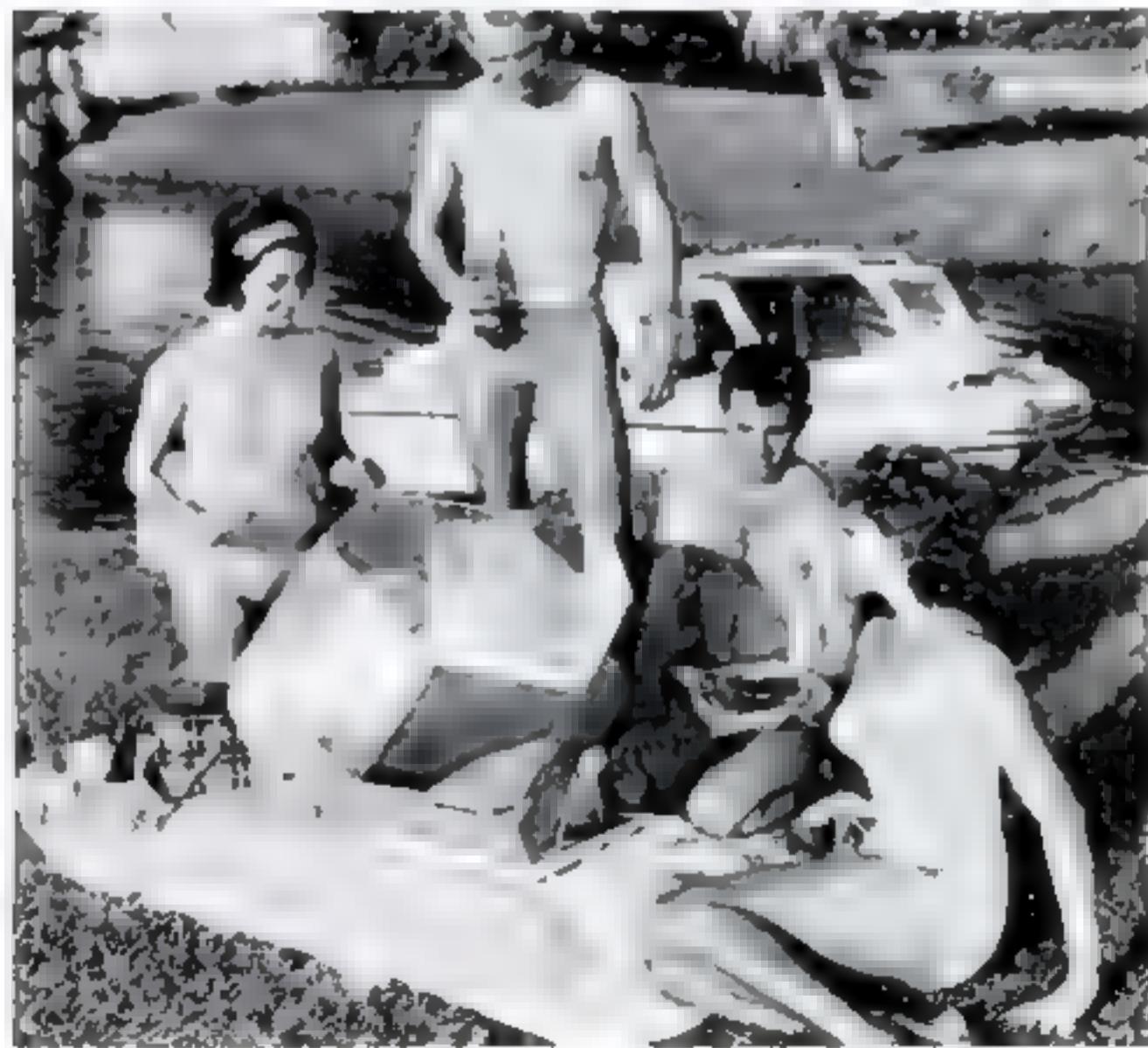
Doorless shower: peekproof, splashproof

Walk into this spiral shower and you're completely enclosed yet need no door or curtain. The idea: no messy curtain to fuss with, no water splashed on the bathroom floor. The curved walls are molded in one piece of fiber-glass and can't rust or rot. Price is about \$250. Swan Enterprises, Inc., 44 Railroad Ave., Greenwich, Conn.



Gas-burning candles last forever

These candles never burn down, never drip. They burn butane fuel—like a cigarette lighter—and last four hours on each filling. Adjustable jets vary flame size and light output. Inside is a transparent reservoir (right) that shows when refilling is needed. About \$24 a pair, Ronson Corp., 1 Ronson Rd., Woodbridge, N. J.



Cook-anywhere solar grill needs no fuel

You don't need fuel or a fireplace to cook a picnic steak with this portable solar grill. The sun does the work. Reflectors funnel its rays through glass plates where their heat is trapped behind an air space. Temperatures reach 400 degrees, cooking meats in 20 to 30 minutes. Folded, the grill looks like a small suitcase. \$29.95, Carver Industries, Parsippany, N. J.



Intense heat fuses cracks in 60 seconds. Grid under burner converts flames to infrared rays.

INFRARED— Quick, New Home Cure for Cracked Asphalt

Machines you can rent for a Saturday afternoon let you mend
blacktop driveways, walks, and patios so they look like new

How you heat-seal a crack in three easy steps

By James Joseph

KEEPING the cracks and potholes out of an asphalt driveway, walk, or patio is one of the toughest yard chores. Makeshift patches rarely hold. Weeds and expanding ice constantly force breaks to open up no matter how often or carefully you fill them.

Now comes a fast new home cure for ailing asphalt—"quick-patchers." These asphalt-patching machines look something like a power mower and contain a high-temperature gas burner that produces intense infrared heat rays. Roll a machine over a small crack, and in seconds it melts the asphalt under it. The softened asphalt then fuses together into a solid seal, and the crack disappears. Large cracks and holes are treated in the same way except that you add a dry-packaged asphalt mix to fill the breaks. The infrared heat softens both old and new asphalt, and fuses them into a single, permanent surface.

The best part about these quick-patchers, normally expensive, is that you don't have to buy one. You can rent a machine for a day's work from a local distributor or tool-rental agency. More and more rental agencies across the country, seeing a booming market for quick-patchers, are adding them to their stock of available tools. The charge is usually about \$10 a day.

How quick-patchers work. The new home-size patchers are actually small versions of the machines used to repair asphalt highways. Their burners are fed from a small tank of butane or propane gas and reach temperatures of 1,600 to 1,700 degrees. The secret of their quick penetration lies in a special nickel or ceramic grid in the burner that converts 50 to 70 percent of the flame's heat into infrared rays. The rays are almost instantly absorbed by the black asphalt and penetrate up to 2" deep. In 60 seconds, the asphalt is soft enough to fuse. At the same time, the intense heat burns out weeds and closes up water-trapping pockets that form ice.

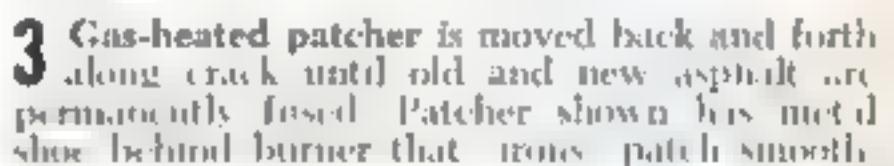
There are several types of patchers, differing mainly in the area of asphalt that they cover. Some are designed especially for small cracks; others handle



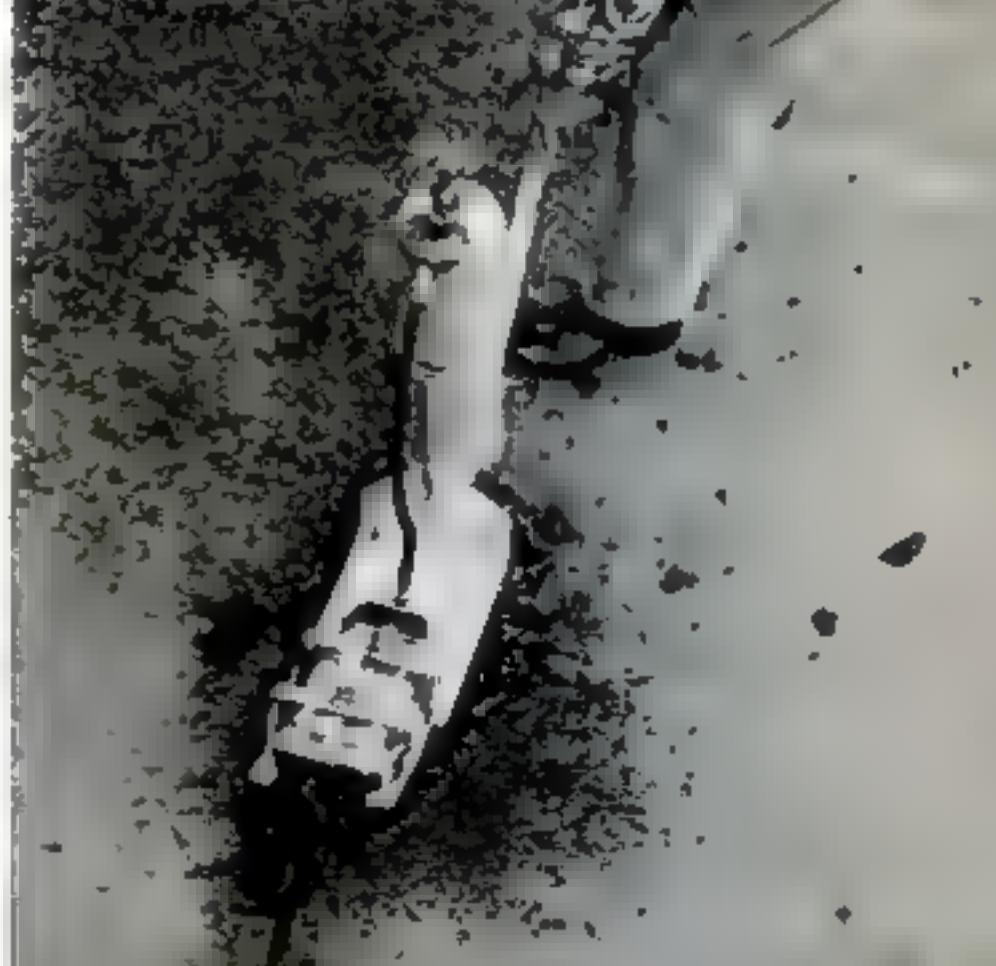
1 Narrow cracks are first opened up wide enough to insert a dry-mix patching asphalt. Use an old chisel or screwdriver and enlarge the crack to about twice its original width.



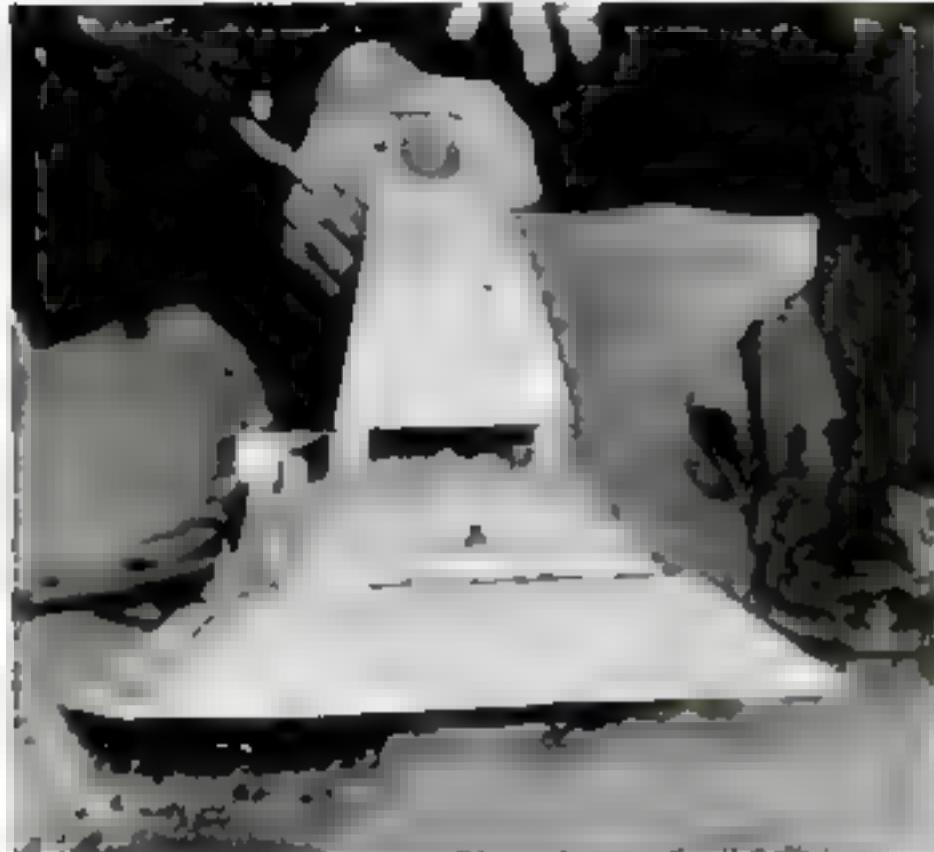
2 Work the dry-mix asphalt into the crack, tamping it firmly down as you go. feather the edges out slightly on each side of the crack—the way you'd patch a crack in plaster.



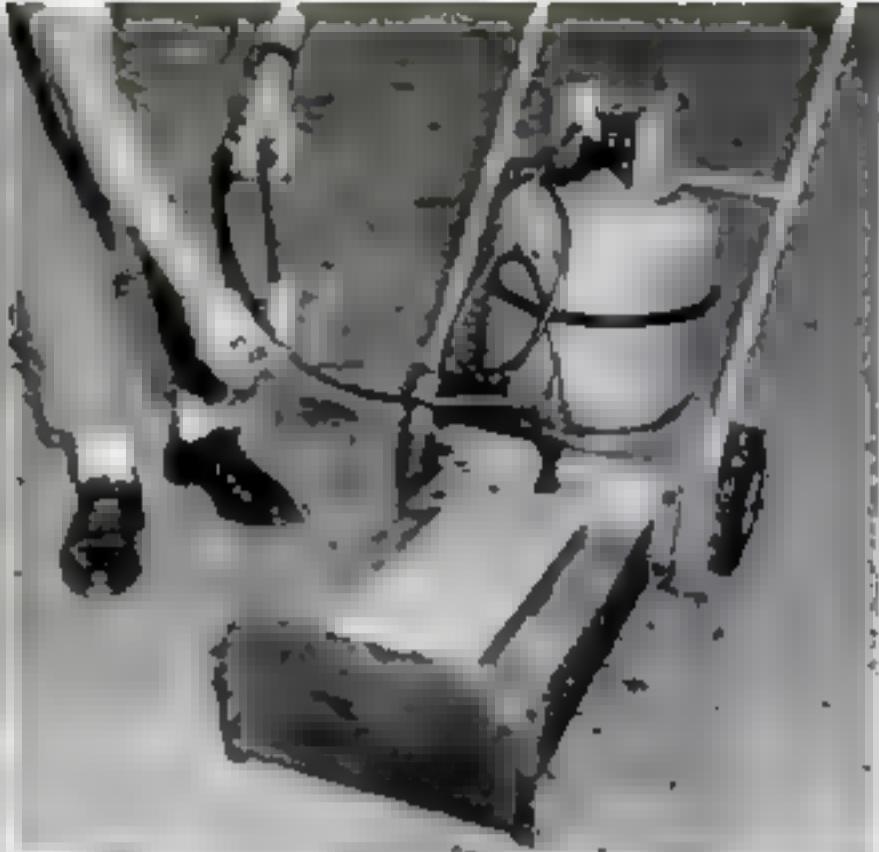
3 Gas-heated patcher is moved back and forth along crack until old and new asphalt are permanently fused. Patcher shown has metal shoe behind burner that irons patch smooth.



Choose a patcher to do the job you need—there are several types



Small, portable patcher is hand-held a few inches above the asphalt, puts out 16,000 BTU of heat. It's easy to use on small cracks, but is not designed for patching large areas.



All-purpose patcher handles both cracks and holes, carries five-gallon propane tank on a two-wheeled cart. Here, igniter hose is lighted first, then used in turn to light the burner.



Hot roller (above) is a specialized form of patcher that combines an 18"-wide drum with an infrared burner. It's especially good for big repair areas that must be rolled smooth.

large holes. Here's how they compare:

Crack-sealer. This has a narrow burner, about 8" wide, that rides ahead of a metal shoe. The burner softens the asphalt on either side of a crack, and the shoe smooths the joint. You use it just like an iron, moving it back and forth until the crack is sealed.

Area patchers. These are designed to cover a large area, as much as 2' by 5' or more, and generally have several burner units. You need one of these if you're going to tackle a large pothole or a hump that you want to soften and then level.

Multipurpose patchers. These have a long but narrow burner, typically 8" by 24", that can handle both large and small repairs. Used lengthwise along a narrow break, it's a crack sealer. Turned side-

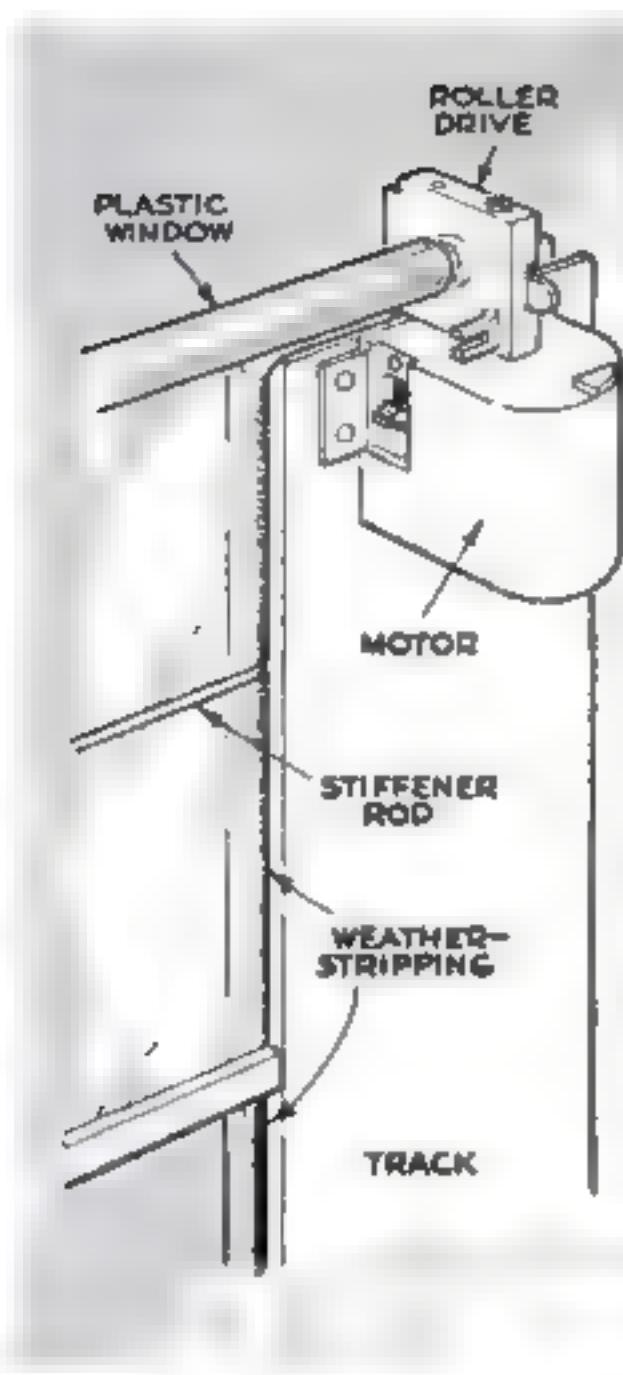
[Continued on page 192]



Large-area patcher is ideal for leveling high spots as well as filling in big potholes. At left, a hump is first softened and the top scraped off. At



right, loose asphalt is screeded level with a board, then heated again to fuse the flattened area into a smooth, inconspicuous patch.



Patio Room Has Roll-Up Windows

Want to turn an open patio into an enclosed sun room? You can with these pre-fab walls and roof of heavy-gauge flexible plastic in an aluminum frame. The plastic, called Plastok, comes clear, translucent, or opaqued, fits in weather-striped runners. Each window is controlled by a motor so

it rolls up or down like a window shade. With two or three good helpers, you can add the room in a day. Guaranteed Weather, Inc., Bradenton, Fla., makes sizes of 10' by 10' to 13.5' by 16' for \$1,422 to \$1,646, uninstalled. Wall sun lamp and gas fireplace grill (not shown) are extra.

Floor-tile adhesive goes on with roller



Here's a floor-tile mastic you can spread with an ordinary paint roller. You wash off the roller with soap and water for other use. The adhesive remains tacky for 24 hours so you don't have to lay the tile right away. Grip-Tite Roll-On Type 10 is put up by Curtis Products, 3233 W. 36th St., Chicago, in quart and gallon cans for about \$1 and \$2.



Calking compound in aerosol cans

With a press of a finger you can lay a bead of caulk quickly around a bathtub or sink, patch cracks, or recondition a boat. White Instant Caulk will take paint. It's \$1.39 a can at Curtis Products, Chicago.

CONTINUED

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**what's new
for the HOME**



Instant-Setting Cement Goes On Under Water

Masonry repairs can be made either above or below water to pilings, sea walls, driveways, and other surfaces with a new cement that bonds into a cohesive mass in minutes. Chip the work down to a solid base; apply wire mesh, if needed, to hold the new cement; and press on the cement by hand, trowel, or with a cement gun. Perma-Cement will adhere to old masonry, wood, or metal. It's made by L. F. Popell Co., 2501 N.W. 75th St., Miami. A 10-pound can costs \$4.98, a 50-pound bag around \$10.



Flip-out ironing board

This self-storing ironing board comes in a cabinet as above or as a counter built-in. Both contain a 33"-high metal board, non-scorch rest plate, electric plug, cord holder, and storage space for an iron. Swanson Mfg. Co., 607 S. Washington St., Owosso, Mich., lists the cabinet at \$85.75, the built-in at \$69.95.

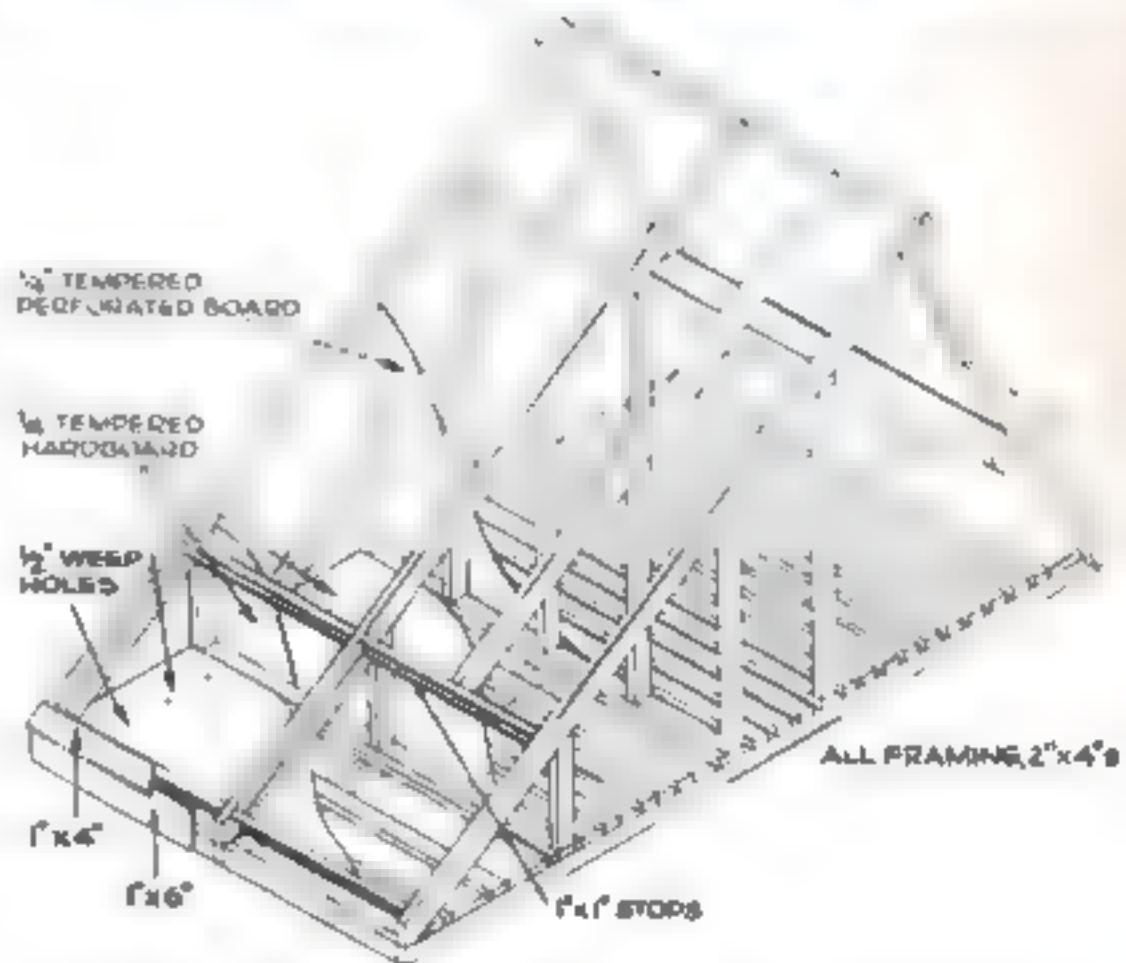
A Handy Garden House You Can Build

HERE'S a garden house packed with extras that make it a center of yard activities. There's a built-in greenhouse at the back and an attractive covered porch in front with a potting bench that doubles as an outdoor shop bench. Under the roof are a 2'-deep walk-in closet for tools and supplies, and a storage shed big enough to park a power mower and other yard equipment.

The best part: Complete plans for building the 8'-by-15' house are available free from Masonite. There's no tricky foundation to install. The entire frame rests on three long skids, simply blocked up on flat stones. The walls and roof are covered with large panels of weather-proof tempered hardboard. Tools hang up neatly on perforated hardboard in the walk-in closet. All frame parts are two-by-fours.

Lift-out windows make it easy to reach potted plants in the greenhouse section at the rear.

Big storage section has room for wheelbarrow, power mower, and other bulky yard equipment.

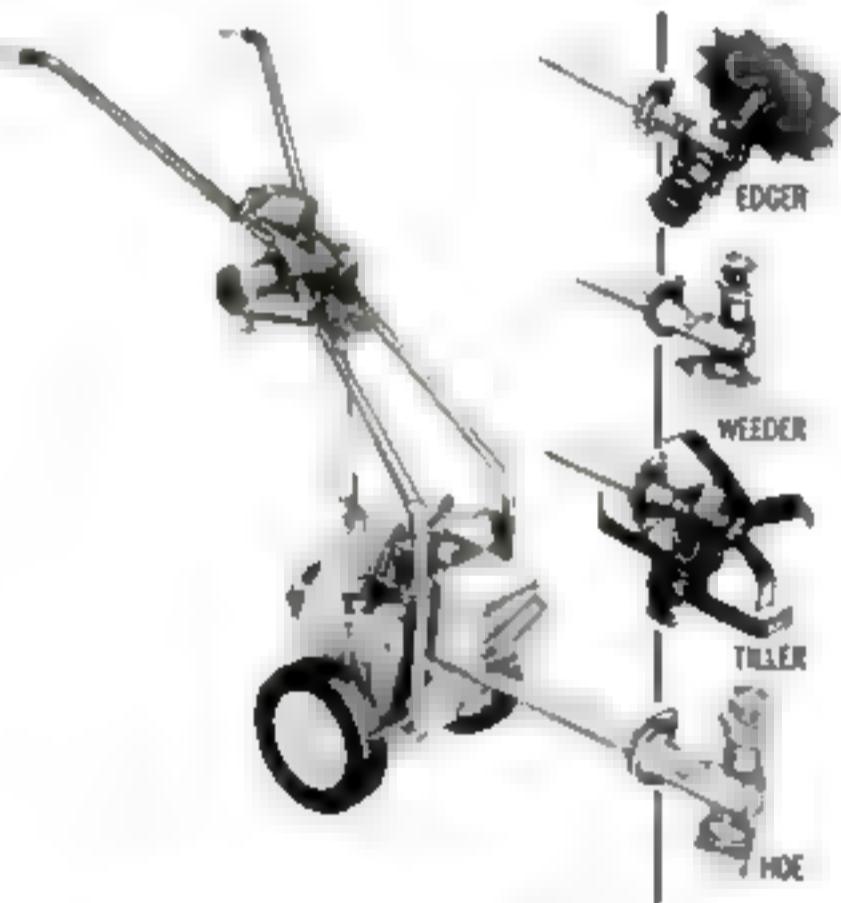


Two-by-four frame has flat floor to let mud and water drain through. Sketch above is one of several you get free from Masonite Home Service Bureau, 29 N. Wacker Dr., Chicago. Ask for plan No. AE-384.





Work-Saver Loading Attachment



All-purpose power tool does many garden chores

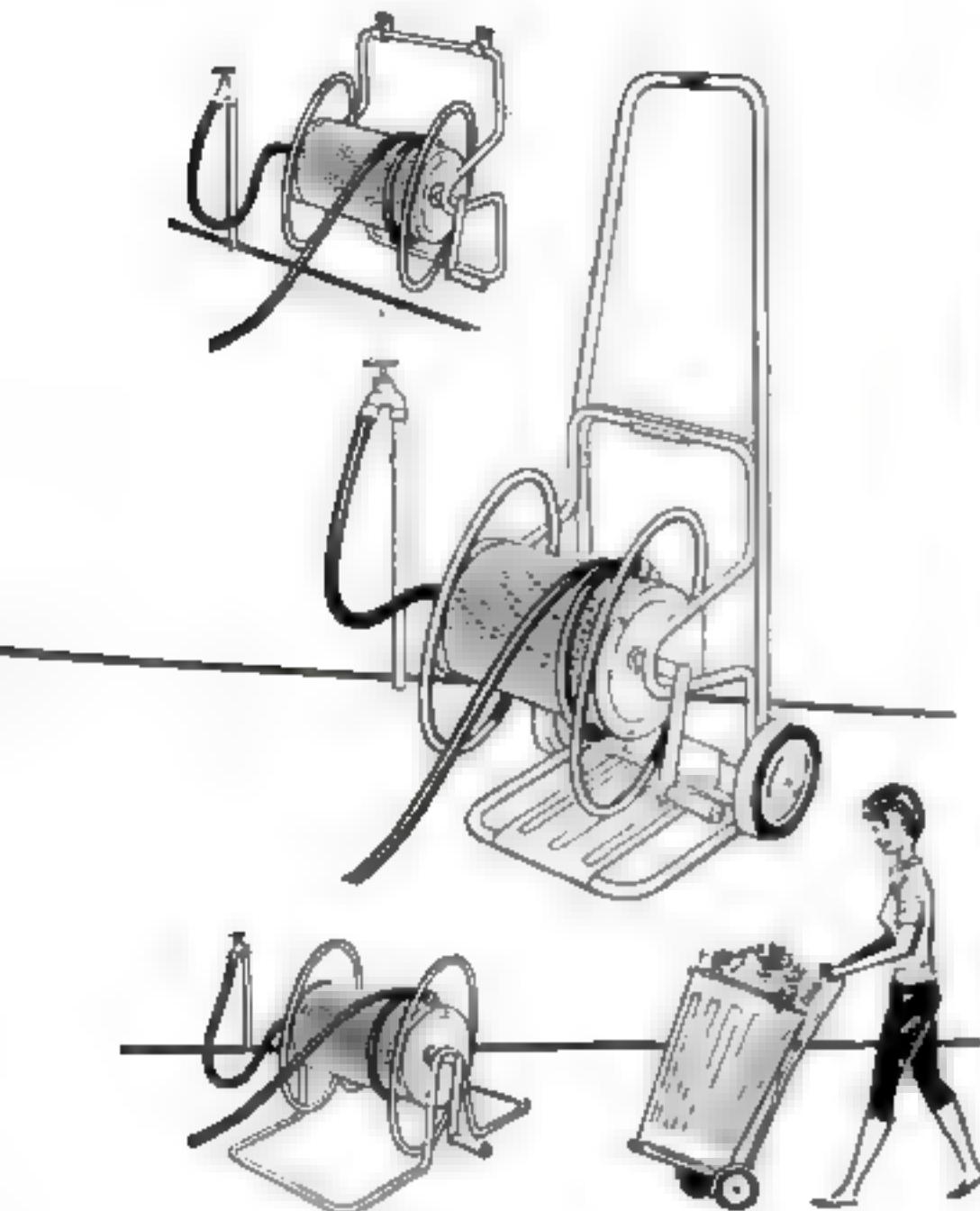
The new Lawn-Boy Hobby Gardener, equipped with interchangeable attachments, weeds, hoes, tills, and edges. Attachments screw on and off quickly. Its extended arm lets it work around plants without damaging foliage, and go where heavier equipment is impractical. A two-horse aluminum engine powers the unit. Price is \$99.50, complete with the four attachments. **Lawn-Boy**, Lamar, Mo.

IDEAL for moving heavy loads about the yard is the Danco all-purpose loader designed for the Jacobsen Chief garden tractor. Features include: twin-cylinder lift with full hydraulic control that can raise a 300-pound payload to a height of four feet, all-welded construction, and bucket lock. Loader, without tractor, \$348. Jacobsen Mfg. Co., Racine, Wis.



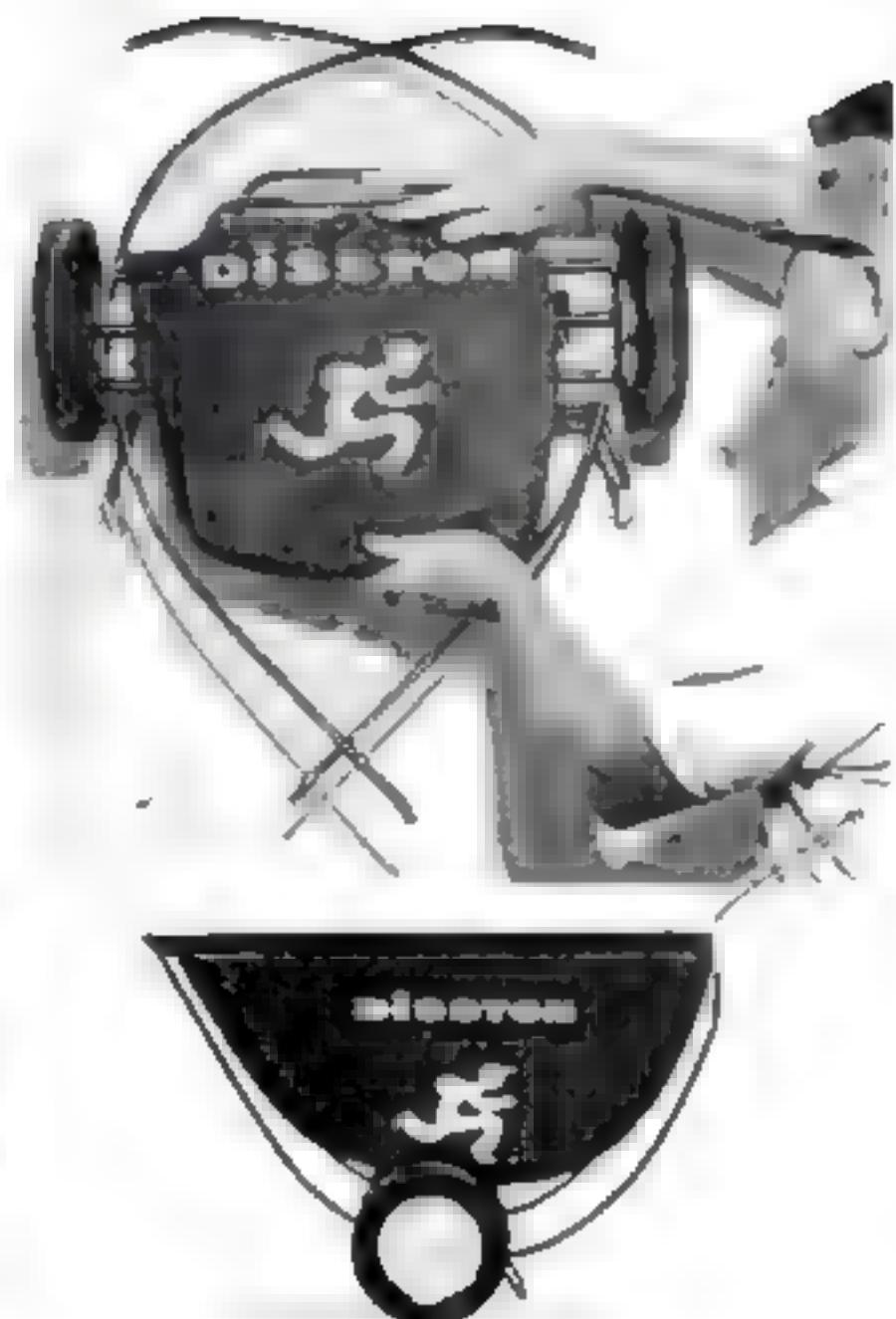
Power trimmer adds neat lawn touch

The new Jacobsen Trim-O power tool, designed to trim lawns quickly and cleanly with a minimum of effort, includes a three-hp. engine, automatic rewind starter, and replaceable side-trim guards. Price is \$97.45. Jacobsen Mfg. Co., Racine, Wis.



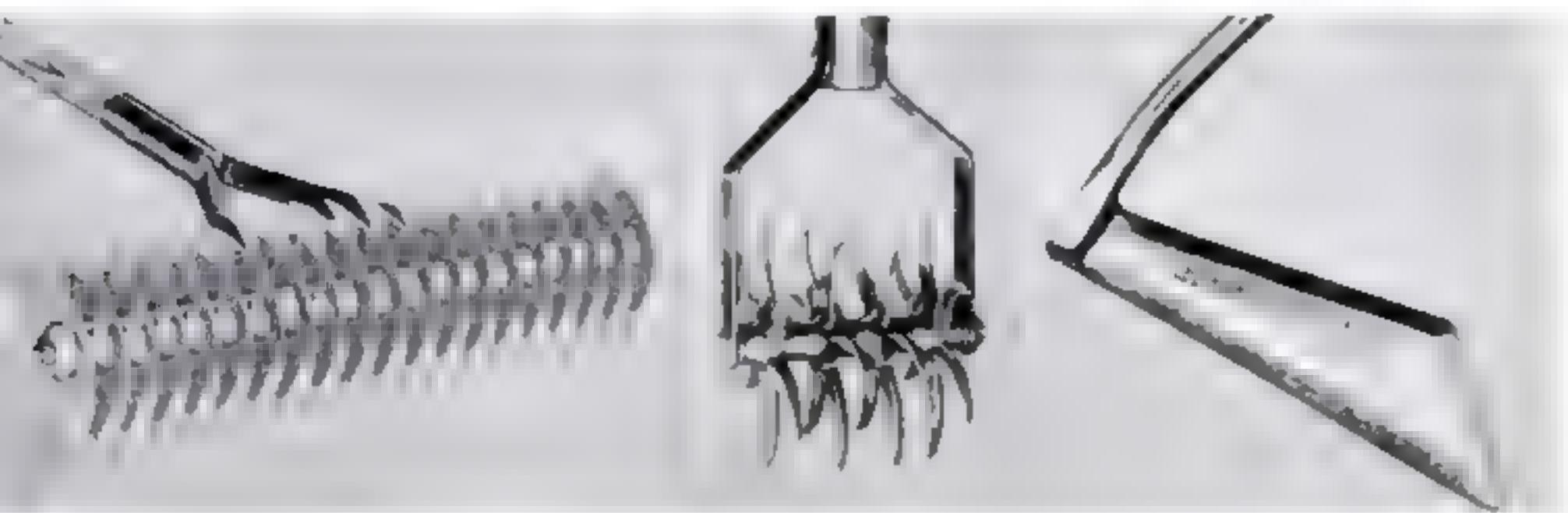
Combination hose reel and garden cart

This Cal-Dak hose reel unwinds when you pull the hose forward, rewinds with a crank. The reel detaches from the caddy for hanging on a wall or use on the ground—or if you wish to use the caddy as a handcart. Price: \$16.95. Cal-Dak, Little Rock, Ark.



Collapsible cart folds to handy size

You can speed the job of handling leaves, grass, and other garden debris with this lightweight canvas cart. It folds compactly for storage on a garage or basement wall. Capacity: 3½ cubic feet. \$10.95. Disston Division, H. K. Porter Co., Pittsburgh.



Tools for grooming the garden

These specialized cultivating tools can make light work of many tedious garden jobs. The lawn-grooming rake (left) is self-cleaning. You don't even have to lift it from the ground. \$4. (O. Ames Co., Parkersburg, W.Va.) The soil cultivator

(center) has four polished six-tine spurs to break up all types of soil with a simple push-pull action. \$4.95. (True Temper Corp., 1623 Euclid Ave., Cleveland.) The Swoe (right) has three edges for weeding, cultivating, grass cutting. \$10.95. (Wilkinson Sword, Ltd., London, England.)

Easy way to haul stones—try an old auto trunk lid

Using an auto trunk lid that cost me less than a buck at a junk yard, I moved several hundred pounds of rock easily and with little lifting. I removed the lock, passed a chain through the hole and wrapped it around a piece of $1\frac{1}{8}$ " pipe placed across the front of the lid for strength.

One afternoon of hauling the lid behind a truck dented it considerably, but it still remained usable.—*Thomas M. Martin, Bedford, Va.*



WOOD LATH

FLAT PLASTIC SOAKER HOSE

ALLOW APPROXIMATELY
4" SPACE BETWEEN LATH

TIE WITH HEAVY CORD,
ALLOWING SLACK
FOR WATER PRESSURE

FOLD HOSE
FOR STORING

Wood strips keep soaker hose flat

It's a nuisance to have to straighten out a soaker hose each time you use it. Here's how I got rid of the problem—at absolutely

no cost. I used some pieces of wood lath because I happened to have them on hand. You could use any other strips. The hose stays put—with the water holes up.—*O. M. Hamilton, Tujunga, Calif.*

Nails help keep concrete patio level

A grid-patterned patio can eventually become uneven due to movement in the concrete or wood. You can minimize the chances of this by studding the redwood headers with 16-penny galvanized nails before pouring the concrete. Keep the nails at least $1\frac{1}{8}$ " beneath the surface.—*R. J. De Cristoforo, Los Altos Hills, Calif.*

►►►I make window screens $\frac{1}{8}$ " smaller than the opening and glue $\frac{1}{8}$ " plastic foam around all sides. When this compresses, it forms an insectproof screen, and I don't have to spend time planing edges.—*Ted Hinton, Vancouver, B.C.*

PHOTOGRAPHICALLY SPEAKING

By Bob Hering PHOTO BY BOB HERRING



Lamps for 8mm movie fans: One signals, one stays cool

Seems projection lamps always choose the most inconvenient time to die. To prevent such abrupt interruptions, Sylvania has developed a dual-filament projection lamp that gives advance warning. It dims for a short time before it burns out. A light-giving coil and a ballast coil are connected in series. The ballast coil acts as a buffer for excessive voltage, lessening the chance of premature failure in the lamp, and keeping it going—though dimmer—for a while.

Another projection lamp—from Westinghouse—has a dichroic reflector: a glass mirror that reflects visible light but transmits infrared (heat) rays out the rear of the bulb. Advantages: cooler film projection and higher light intensity on screen while burning at just half the usual operating temperature.

First SLR still camera with built-in zoom lens

One of the better new camera buys to arrive so far this year is the Nikkorex 35 Zoom. I've been using one for about a month and find that it has a lot to offer. Most important: It brings zoom-lens photography within reach of quite a few more pocketbooks. At \$219.50, the camera isn't cheap, but look what you get:

By merely turning the zoom ring on the lens barrel you vary the focal length from 43mm wide-angle to 86mm telephoto—all within one lens. This gives you the advantage of interchangeable lenses without bothering to lug along extra ones. It's a neat vacation package.

The camera is semiautomatic—a built-in exposure meter couples to both shutter and diaphragm. You need only line up the needle with the index mark.

Four rings on the lens barrel make it easy to adjust the camera. One controls aperture opening and includes the ASA scale; another controls shutter speeds; a third changes focal length of lens; and a wide fourth ring adjusts the focus. Without moving your eye from the viewfinder, you can focus, select the focal length for best framing, and adjust the meter needle for the correct exposure.

The meter needle is visible in two locations: through a little window above the exposure cell on top of the camera and through the viewfinder. Despite its "long nose," the camera is comfortable to hold. You're working the rings and supporting the lens barrel at the same time.

Automation in space

An aerial-reconnaissance system that will take exposed film from an aerial camera, automatically develop it, and elec-



PHOTOGRAPHICALLY SPEAKING

tronically scan the 4½-by-4½ frames for transmission to a ground recording station is being developed by CBS Laboratories for the Navy. The photographic quality of the system, the company says, will permit immediate analysis of the picture.

Adding sound to a silent projector

Would you like to add sound to your 8mm films without discarding your present silent projector? You can do it now at a reasonable price. Sears sells an adaptor that fits most of the present 8mm projectors that have drive sprockets. Previous adaptors fit only one or two models, or, if adaptable to several projectors, were expensive.

Basically, Sears' adaptor is a tape recorder synched with your projector, and depends on sound striping on the film. It is not designed for use with commercially produced 8mm sound films, but is meant primarily for adding comment to your own films—those you intend to play back on the same machine.

Sound-striping service is available through photo dealers, or you can add your own, using one of the new stripers.

In operation, the film runs past the recording head of the adaptor unit and then through the projector. It not only records and plays back, but permits automatic erasing and re-recording.

Yes, it can record music, but you may be disappointed in the quality.

Price of the adaptor: \$99.95. I'd suggest you try one on your projector before buying—just to make sure the noise level is low enough for acceptable sound.

New multipurpose flash bulb

To take the guesswork out of selecting the right flash bulb, Westinghouse is introducing a single bulb that should handle most of the flash situations that come up for the amateur or professional. The M3 will take the place of No. 6, M5, and M25 bulbs. A shredded-zirconium filling in the new bulb comes to a high intensity level (twice the light output of shredded aluminum) quickly and maintains it for a long time. It can be used with most focal-plane shutters, all leaf-type shutters,



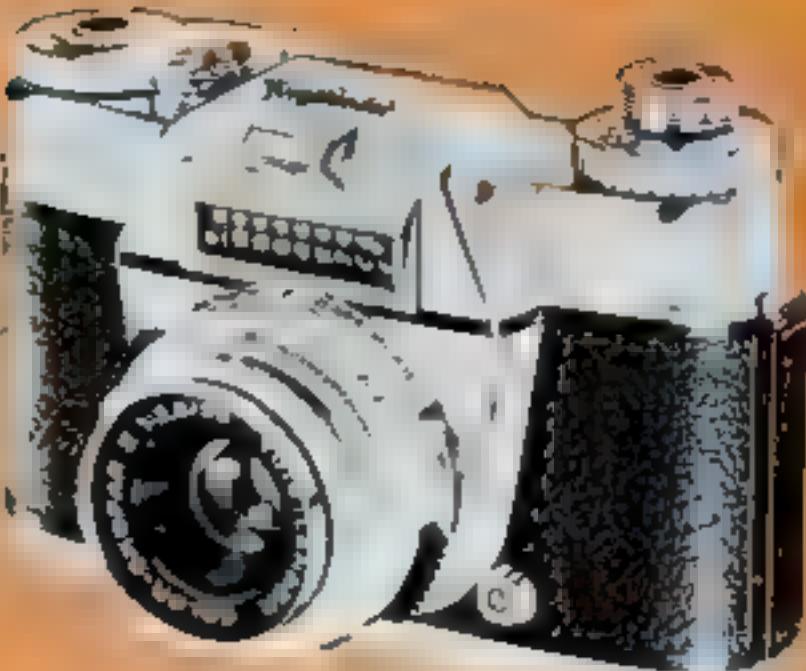
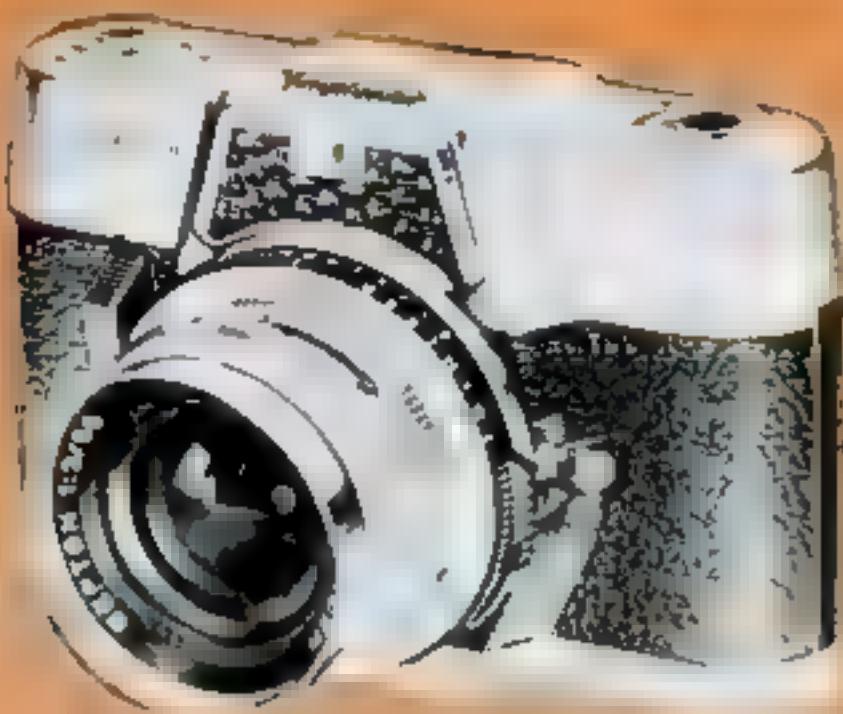
Strobonar flash increases output

Designed primarily for use with rechargeable nickel-cadmium batteries, the Strobonar 65C electronic flash has a built-in battery charger, fast cycling, and 81 percent more light intensity than the Futuramic II. The charger plugs into a household circuit. Batteries are also recharged when the flash is operated on AC power. Price: \$84.95. Honeywell Photo Products, 4800 E. Dry Creek Rd., Denver 10.



Electric-drive 8mm movie camera

Pushbutton zoom control on this Keystone K-14 lets you change smoothly from wide-angle to tele range (9mm to 27mm). A built-in coupled exposure meter responds instantly to light changes. Other features include reflex viewing and an indicator in the viewfinder to show lens setting and warn when light is too weak. Penlight batteries provide power. \$249.50. Keystone Camera Co., Boston 24.



SLRs Go Automatic

Two 35mm single-lens reflex cameras, new from Voigtlander, follow the trend toward automation. The Ultramatic gives you fully automatic exposure control plus semiautomatic and manual control. Look through the viewfinder and you see, along the outer edge, a number that shows the shutter speed, a scale and pointer to indicate the aperture setting, and a small ring

to tell when compensation is being made for filter factor or backlighting. A signal indicates when the light is too high or too low for satisfactory exposure.

The new Bessamatic Deluxe is similar to the standard Bessamatic, except that the aperture and shutter settings show in the finder. It is \$229; the Ultramatic, \$295. H. A. Bohm & Co., Chicago 45.



Now it's "talking" slide projectors

There's a completely new audio-slide system: a projector using sound-slide mounts surfaced with the material used on tape—a coating of magnetic oxide. After your slides come back from the processor, you slip them into the mounts, and a special record-

ing head that revolves in a spiral path over the mount adds sound. Each mount holds 20 seconds of recording. You can re-record as you do on tape. You can also run soundless slides with live commentary, using the mike and amplifier as a P.A. system. Revere 435 projector lists at \$250. Revere Camera Co., Chicago 16.

what's new

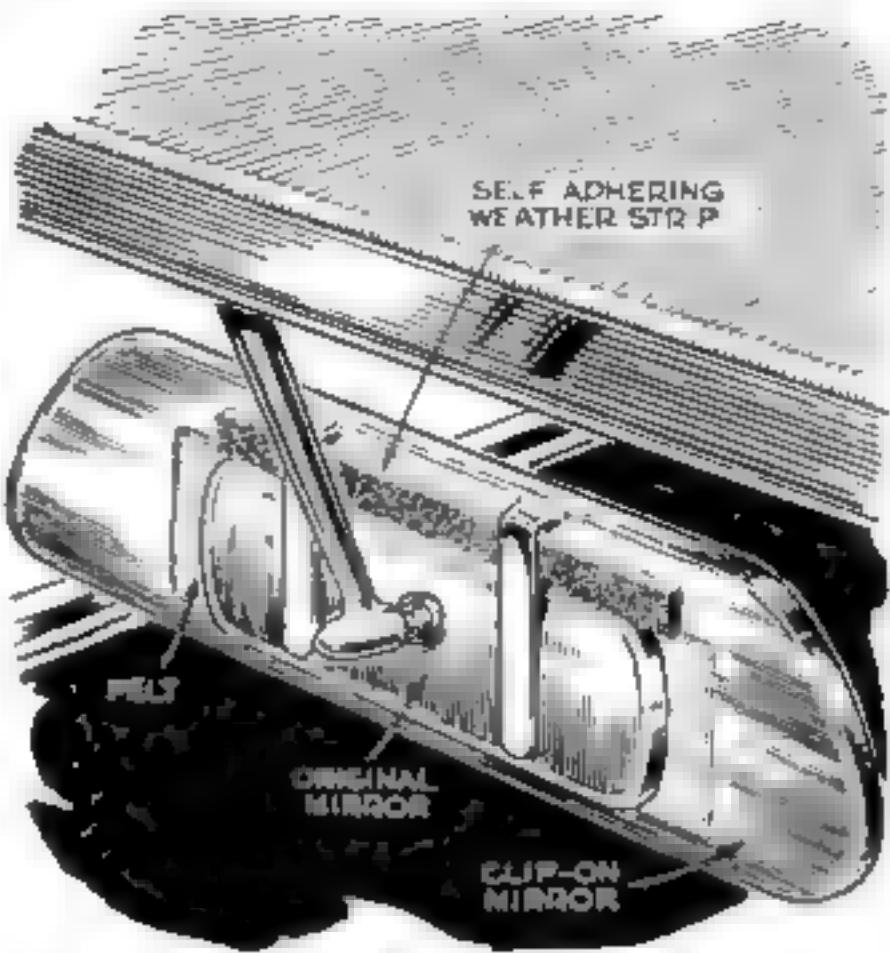
PHOTOGRAPHY



Hints from the Model Garage



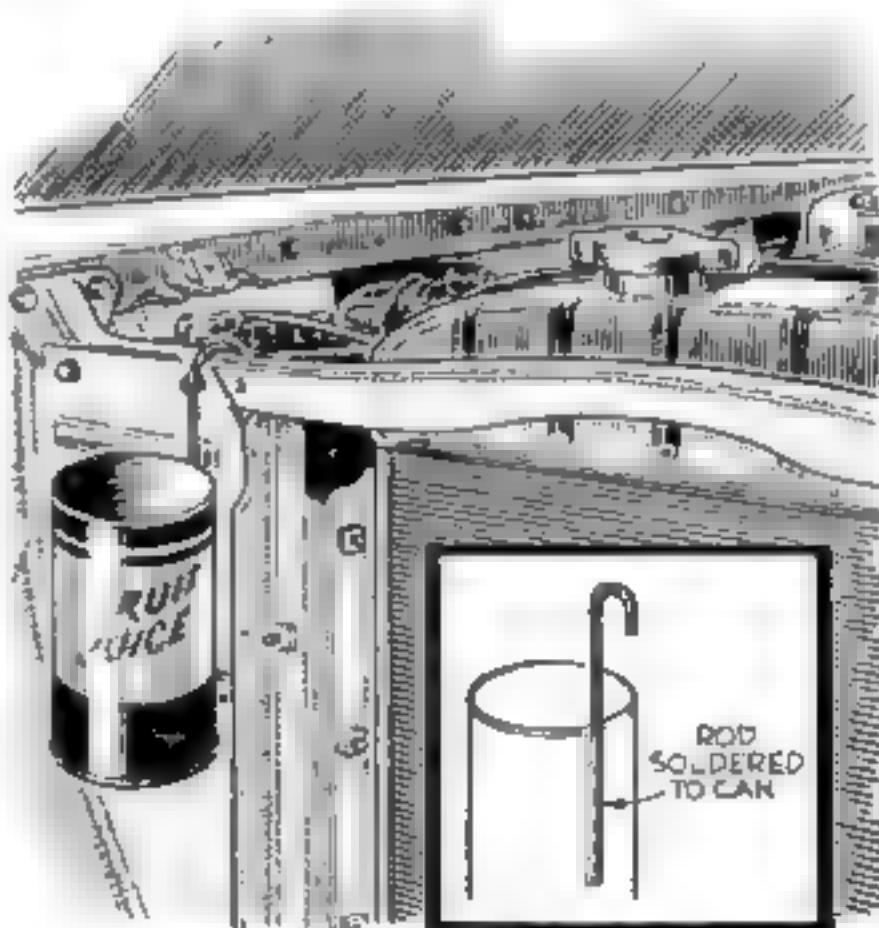
To blow dirt from around spark plugs before you remove them, use an empty snap-off-cap plastic detergent bottle. A few good squeezes will whisk the dust away. The same method can be used to blow lint out of heaters without damaging them.



That oversize clip-on mirror won't loosen and rattle if mounted this way. Place a length of weather stripping just above the stock mirror to carry the weight of the clip-on. Cement a piece of felt to the back of the clip-on to absorb vibration.



Hold cans upright in a truck bed with inexpensive, readily available magnetic cup hooks. Bend each hook closed to form an eye. When slipped over the neck of the can, the eye keeps the can from overturning and perhaps spilling its contents.



A container for holding small parts can be a big help when you're working under the hood. Use a small tin can and a foot-long piece of rod bent into the shape of a cane. Solder the rod to the can and form the hook to fit the top of the radiator guard.



Volkswagen's factory specifies Champion spark plugs.

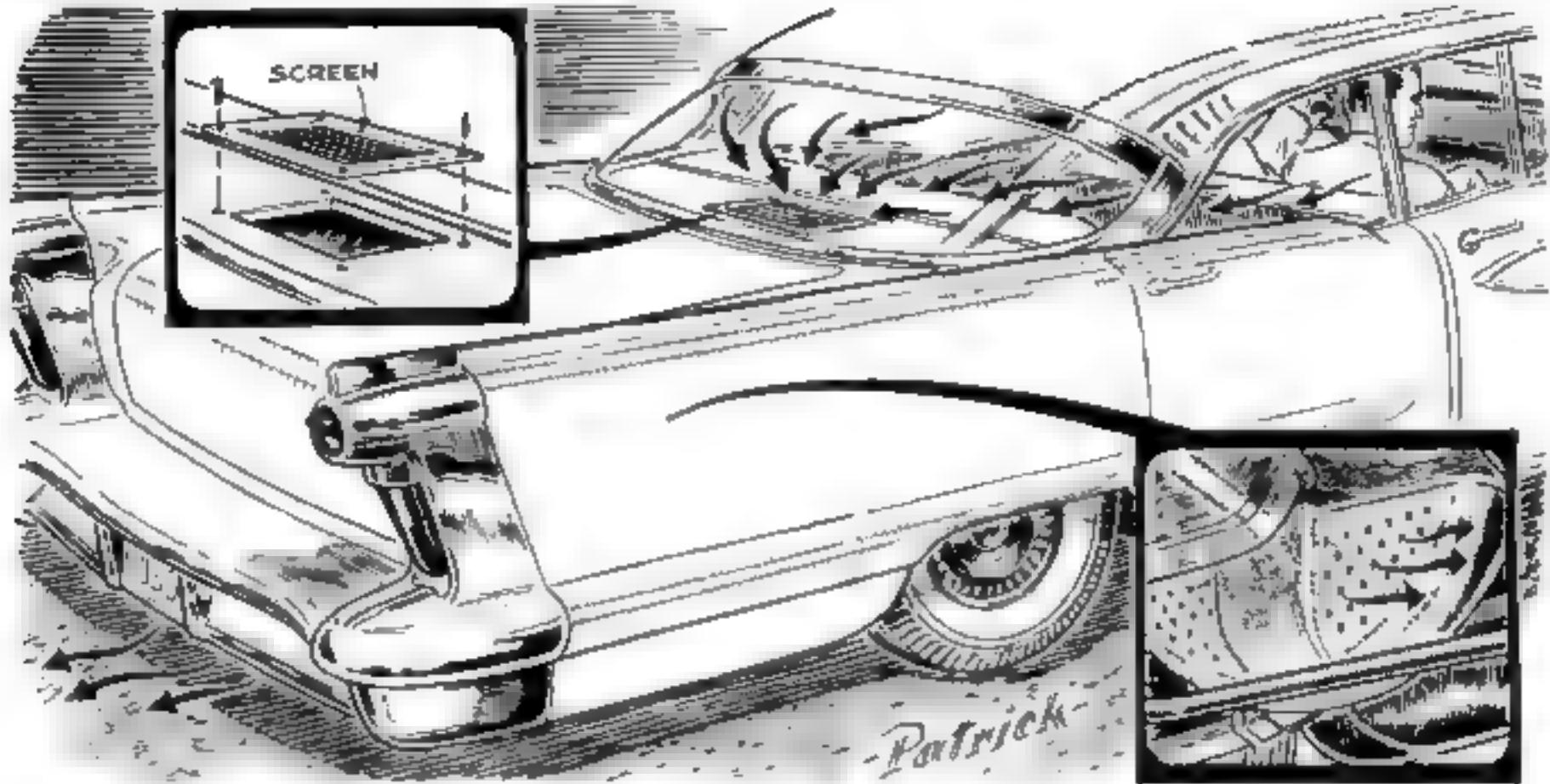
Volkswagen uses Champion spark plugs because they give the utmost in dependability and efficiency. Actually, more than twice as many car makers the world over specify Champions. Why settle for less in your car?



CHAMPION

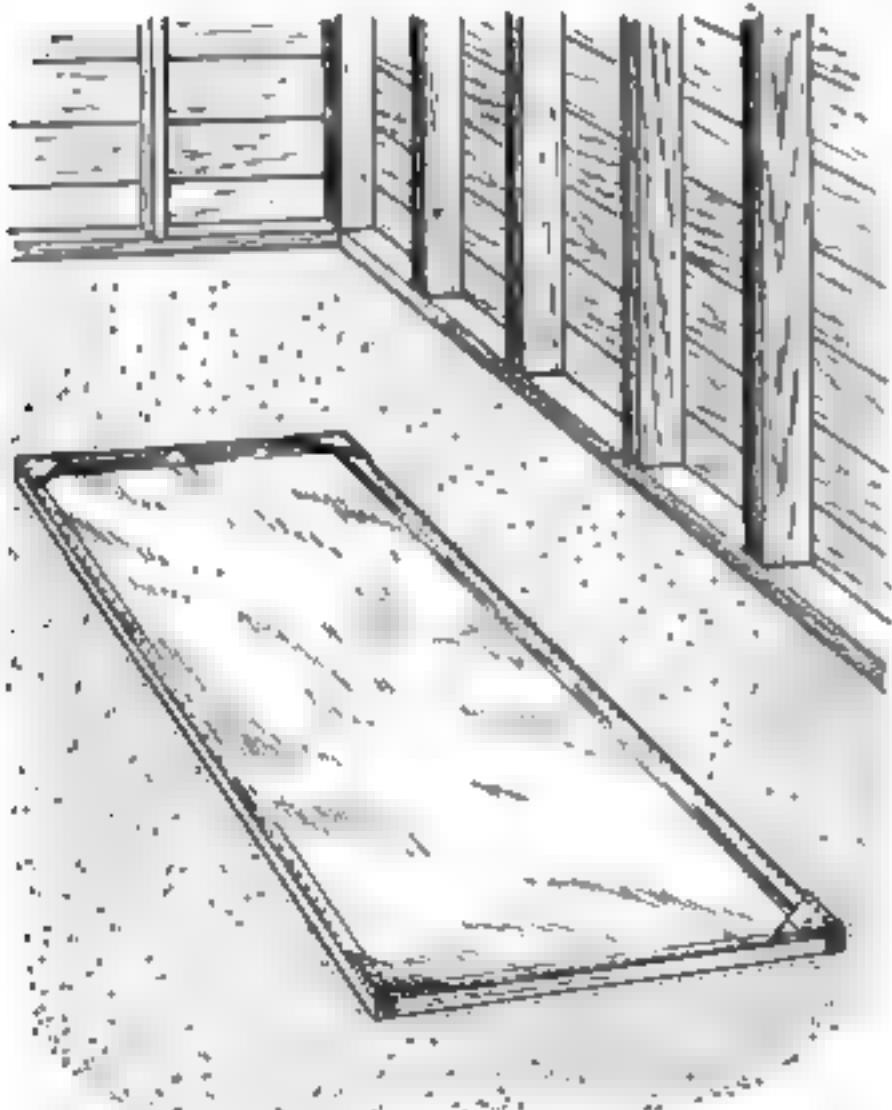
For maximum engine efficiency
In your own car Install new
Champions every 10,000 miles

More Hints from the Model Garage



A rear-window air-exhaust duct provides ventilation without need for open rear windows. Cut an opening in the rear-window shelf (most late-model cars come with a cutout for a rear speaker in the metal bracing under the cardboard) and install a

metal screen. Then drill the sides of the spare-tire well full of holes to allow the air to flow out of the trunk. Locate the holes where water can't splash in. Vents under the dashboard will give adequate air flow. Closed windows eliminate draft.



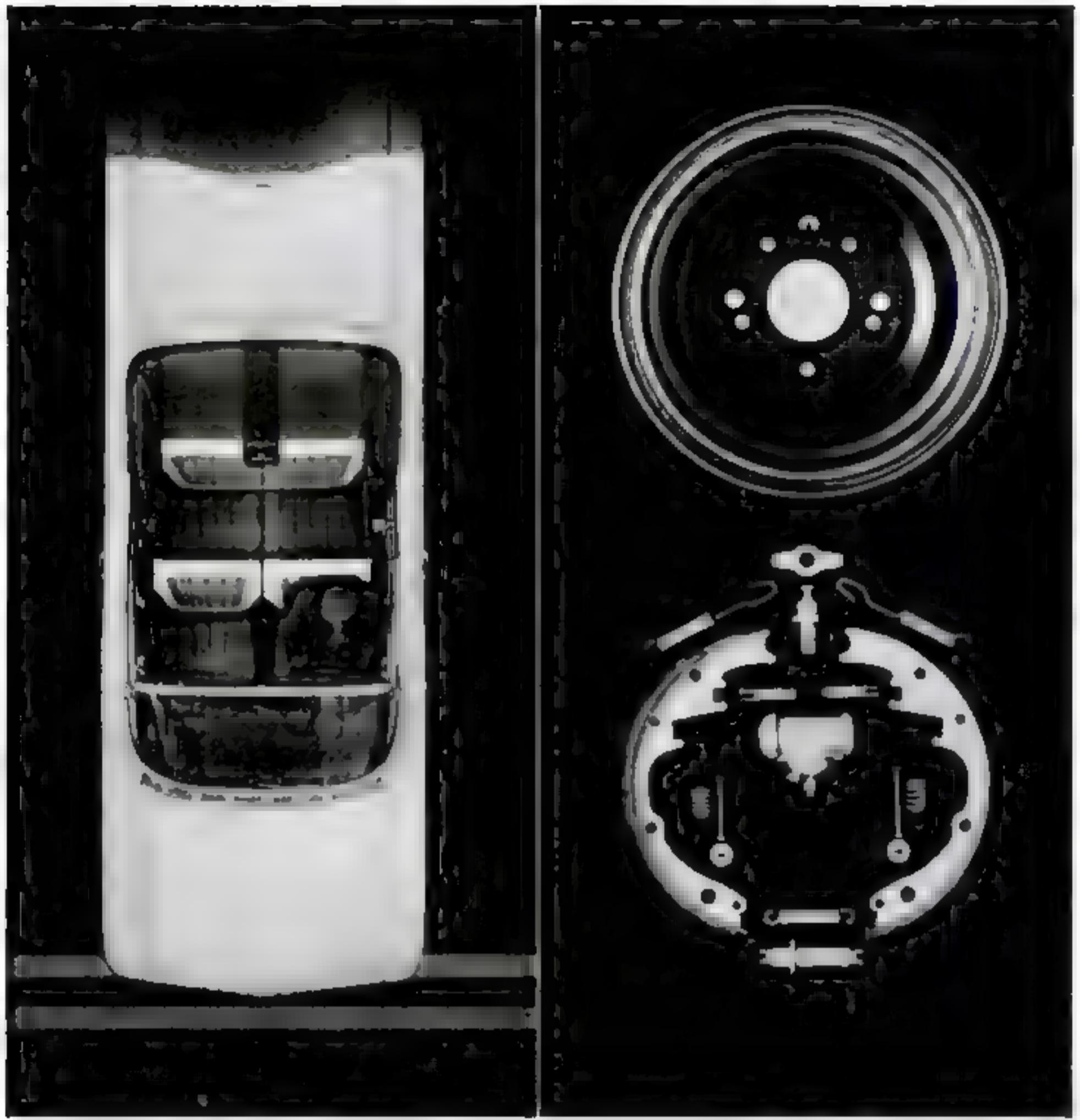
To keep your garage floor clean, build this simple pan for catching grease drippings. From one-by-one stock, cut two 7' and two 2' lengths. Form a frame, brace the corners with plywood, and staple on an inexpensive plastic dropcloth.

Do You Have An Auto Hint? Send It in and Win a Prize

HAVE you discovered or developed a money-saving short cut for making your own auto repairs? Have you found an easier way to do a difficult job? Got a tip that will make driving safer or easier? Or do you know someone who has an original tip, one not previously published?

POPULAR SCIENCE will pay a cash prize of \$15 for every auto-repair hint accepted for publication each month in "Hints from the Model Garage."

Describe your idea as completely as you can in words. Add a pencil drawing, or shoot a photo, if you feel that this will make it more easily understood. Address your entry to Model Garage Editor, POPULAR SCIENCE, 355 Lexington Ave., New York 17, N.Y.



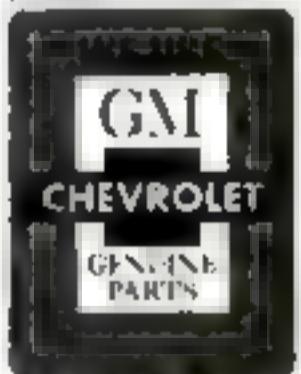
stop

better

When you want your Chevrolet to stop like new again, ask for GENUINE CHEVROLET REPLACEMENT PARTS

When you need new brake linings for your Chevrolet, doesn't it make sense to get the kind that were on your car when it was new? That means genuine Chevrolet replacement linings, built especially to restore your Chevy's original reserve of safe, straight-line stopping power. And because they're formulated to Chevrolet's high quality specifications, you know they'll give you long, dependable service. (Chevrolet linings are bonded to the shoes; there are no rivets that can possibly damage the drums.) Like all genuine Chevrolet parts, they're readily available at your Chevrolet dealer's and at leading independent garages and service stations. . . . Chevrolet Division of General Motors, Detroit 2, Michigan.

LOOK FOR THIS SIGN



IT PAYS TO KEEP
YOUR CHEVY THE
CHEVY-EST

Gus Matches Wits with

By Martin Bunn

"**G**US WILSON," Silas Barnstable called as he walked through the doorway of the Model Garage. "I want to ask you a question."

Gus tightened the last of the plugs he was installing and turned to greet the town's most notorious skinflint.

"Good morning, Silas," he called cheerfully. "Be with you as soon as I wipe my hands."

"Won't do you no good to clean those slippery fingers of yours," Barnstable snapped. "You'll not dip them into my pocketbook."

"Wouldn't risk getting them caught in that mousetrap you keep in there," Gus countered good-naturedly. "What's on your mind?"

"I read in a book about how some feller stopped a leak in his radiator by putting in oatmeal. Now, you give me a straight answer. Will it work?"

"As a matter of fact, it has worked," Gus replied. "But just as often, the oatmeal clogged the whole system. You ought to let me take a look at the radiator now. It'll cost you five times as much to get the radiator cleared after you feed it mush."

"Didn't say I was going to feed it mush," said Barnstable, glaring. "I just wanted to hear what you had to say about oatmeal before I spent good money to get the leak fixed over at the Discount Repair Shop. The prices they advertise are half what you charge, Wilson. Besides, I don't need a fancy mechanic to fix a little leak." He turned to leave and bumped into Gus's assistant, Stan Hicks, almost knocking two containers of coffee out of Stan's hands.

"Humph!" Barnstable snuffed. "No wonder your prices are so high. The customers have to pay for your coffee breaks." He walked to his car and drove off, leaving a trail of water on the road.

"What's the old miser been trying to get for nothing?" Stan asked.

Gus told him, and Stan laughed heartily.

"Wait till those sharpshooters at the Discount Shop finish with him. He'll be back begging us to take his money."

"I wouldn't say that," said Gus. "But I'll bet we haven't seen the last of him. Let's have our coffee and get to work on this brake job."

Several days passed before Gus's prediction came true. The sound of a horn honking impatiently outside the shop announced Silas' return. Great clouds of steam billowed from beneath his car.

Stan was alone in the shop. "So, you did it anyway," he called as Silas drove in. "You went ahead and put oatmeal in your radiator after Gus warned you not to."

"Didn't do any such thing," Silas shouted over the hissing steam. "She started boiling on the way over here and there wasn't any place I could stop to get water."

"Thought you were going to get it fixed at the Discount Shop," Stan shouted back.

"No sirree!" Silas exclaimed. "Those robbers over there wanted to put in a new radiator for \$59. Told me there wasn't much sense in trying to fix up a sieve like this."

"So now you've brought your troubles back here."

"No such thing!" Silas answered. "I went home and did a little detective work myself and"—he beamed proudly—"I've found the trouble. Bring a light and I'll show you what to do." He raised the hood. The steam had subsided, leaving a pool of water beneath the car.

Stan hung a trouble light on the upraised hood and Silas pointed to a thin line of rust originating at a point about halfway up the radiator. "There she is. Now, you fix that and nothing else," he ordered.

Stan inspected the area. "Looks like a leak, all right, Silas," he said. "But I don't see how you could lose so much water from a pinhole like that."

"Stop trying to make a big job out of a little one," Silas grumbled. "What's the cheapest way to fix it?"

a Miser



"Good thing I didn't pay you," roared Silas. "Can't a man find an honest mechanic any more?"

Springtime Tips for



for round-the-block spins



**FIRE-RING
SPARK PLUGS**

TUNE UP WITH AC SPARK PLUGS FOR FULL POWER AND ECONOMY — Winter weather likely has taken its toll of engine vitality, especially ignition parts. That's why a spring tune-up alone is not enough. Your car needs new AC Fire-Ring Spark Plugs, too, if you are to get smoother pickup, greater economy, and peak performance this summer. Only ACs have the self-cleaning Hot Tip to help give more mileage and increased power by keeping power-robbing deposits from forming. For superior performance, insist on AC Fire-Ring Spark Plugs. They're best for all cars.

Carefree Summer Trips



AC SPARK PLUGS ■ THE ELECTRONICS DIVISION OF GENERAL MOTORS

...and turnpike travel

INSTALL A NEW AC OIL FILTER FOR SMOOTHER ENGINE PERFORMANCE — Flush winter-worn, dirt-laden oil from your crankcase and fill with your favorite brand of fresh, clean oil. Then keep it clean with a new AC Oil Filter — the oil filter that's standard equipment on all GM cars. When you buy AC, you get the oil filter that's specifically designed for your car, whatever its make and model. You get the best in continuous engine protection with AC's positive filtering action because it removes harmful grit and abrasives. Remember, the cleaner your oil, the smoother your car's performance.



OIL FILTERS

"Well," Stan said thoughtfully, "the right way would be to remove the radiator and solder it, but maybe I can save you some money with an old boilermaker's trick." He went to the bench and, after a few minutes, returned with a long, slender bolt, a nut, several washers, and two pieces of rubber cut from an inner tube. He slipped a washer and a rubber disk on the bolt, passed the bolt through the radiator core where the leak appeared to originate, and put the second rubber disk and washer on the end of the bolt protruding through the opposite side of the radiator. Then he tightened the nut, squeezing the rubber firmly against both surfaces of the radiator.

"There, that ought to do it," Stan straightened. "The pinhole's still there, but the rubber has sealed both ends of the core so the water can't escape." He dragged a hose to the car and filled the cooling system.

Silas inspected the repair carefully. "See, I told you," he cried jubilantly. "There's no leak now."

Stan wrote out a bill. "That'll cost you just 75 cents," he said.

"Seventy-five cents for 10 minutes' work!" Silas complained. "Bet you could've done it in five if you'd wanted to. Anyway, I'm not paying till I'm sure you've done a good job." He started the engine and drove out.

When Gus returned a short time later, Stan was still outraged. He blurted out a full report, waving the bill.

Gus cautioned his assistant, "Careful, Stan, or you'll boil over. I thought you knew Silas well enough not to let yourself get all worked up."

"Can't help it, Gus. I hope his hood blows off next time." He had hardly finished the sentence when a loud hissing and clouds of steam filled the garage entrance. Silas drove into the shop, killed the engine, and stepped out of the car, shaking a knobby fist at Stan.

"Good thing I didn't pay you," he roared. He turned to Gus. "Can't a man find an honest mechanic any more? Don't know

what this town's coming to, what with thieves charging 75 cents for a 10-cent bolt that didn't even do the job."

Stan jumped forward, jaw thrust out. "Isn't my time, the tools, and this shop worth anything?"

"Here, hold on, you two," Gus intervened. "There's a misunderstanding here or my name isn't Gus Wilson."

"Your name'll be mud if you don't tear up the bill this amateur mechanic made out for me," Barnstable bawled. "Hum and his boilermaker's tricks!"

"I fixed his radiator just like he asked me to—the cheapest way possible." Stan

glared at Silas. "Can't blame me if he wouldn't let me check the entire cooling system."

Gus raised the hood and inspected the repair Stan had made. "Silas," he said, "you still owe 75 cents. Stan did a fine job on that repair. There's no wetness around it and the radiator seems perfectly sound otherwise. Let's call a truce while we try to find the real cause of your trouble." He turned to his assistant. "Start the engine while I fill the radiator."

Gus twisted the pressure cap on tightly after bringing the water level even with the filler neck. He called to Stan, "Keep her idling until she reaches normal operating temperature."

Making conversation while the engine warmed up, Gus said to Silas, "I hear they wanted to replace your radiator for \$59 over at the Discount Repair Shop, instead of repairing it."

Silas didn't reply, and the next five minutes were spent in silence until Stan called out, "Okay, she's warm."

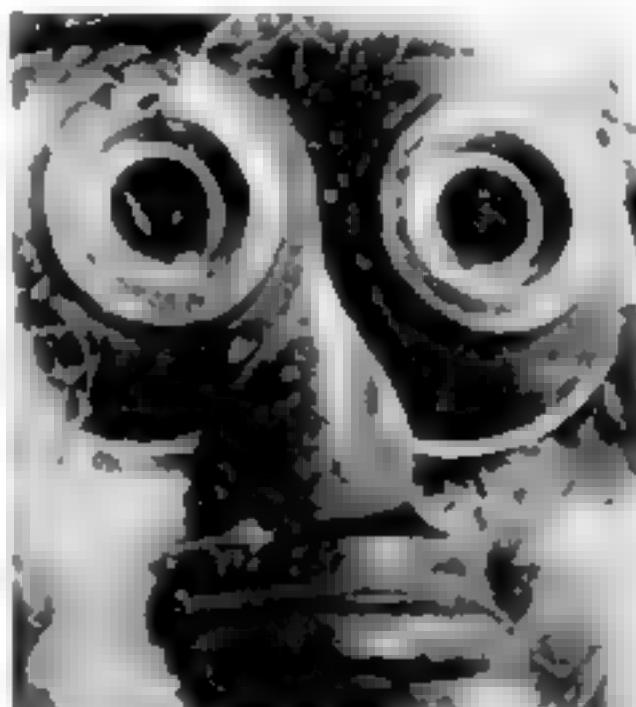
Except for a few random drops of condensed steam still dripping from the radiator frame and front-end linkage, there was no sign of a leak from under the front of the car.

Gus walked around to one side, and then suddenly turned to Silas. "Are you still saving your antifreeze in gallon jugs from year to year?"

Silas smiled disdainfully. "Yes, but that

CONTINUED

What's this a photo of?



ANSWER: The face of an open hall-buried among some bushes.
No, just a two-headed spider!

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10,000 more safe miles
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You can't buy a better tire . . . to save your life . . . than ARMSTRONG!

has nothing to do with it. Charlie Grimm down at the gas station tests it free after I pour it in each fall. It always checks out for about 10 below zero. Been using the same stuff for four years."

"Still saving the pennies to spread the dollars," Gus remarked dryly.

"Me?" Silas snorted. "Keeps its strength because I drain it back into the jugs at first sign of spring. Good thing I drained it a couple of weeks ago, or I would've lost it all with this leak."

"I thought so," Gus said as he rolled beneath the car on a creeper. "Here's the trouble, Silas, and you've caused it yourself." He called to Stan, "Cut the engine and toss me a hammer, a punch, and a freeze plug to fit this model."

Stan handed Gus the tools and a thin metal disk about the size of a silver dollar as Silas leaped to protest.

"Goldang it, Gus Wilson, are you trying to tell me I let my engine freeze? I told you before that it was definitely protected all winter."

Gus ignored him. The sound of light hammer blows against metal came from beneath the car, followed immediately by the gurgle of water running onto the shop floor.

Gus appeared, holding a metal disk impaled on the punch. The disk was rusted through; it was obvious that the punch had pierced it with little effort.

Silas looked at the water rushing across the floor to the storm drain, then scrutinized the rusted disk. "What have you done to my car?" he demanded. "And what in tarnation is that thing?"

Gus handed the disk to Silas. "It's a freeze plug," he explained. "There are six of them pressed into core holes cast in the lower part of the engine block. For your sake, I hope the other five are in better shape than this one. Some of them are hard to reach and, believe me, they can take hours to replace."

"But I told you," Silas argued. "The engine never froze."

"Didn't say it did." Gus held up the new disk. "See how thin this metal is—about a sixteenth of an inch. Your foolish economy protected the engine against freezing, but stopped there. You tell him Stan," said Gus, grinning. "I haven't got the heart."

"That old antifreeze gave no protection

against rust. After the first winter's use, the rust inhibitor in the antifreeze exhausted itself." Stan spread his hands wide.

"From then on, corrosion ran wild with nothing to check it. It's fortunate that these disks rust through before the block is badly damaged. They give a word of warning to the wise," finished Gus.

"But why did you call them freeze plugs?" Silas persisted.

"Because they've been called freeze plugs for years," Gus answered. "When those early thick-walled engines froze solid in winter, mechanics noticed that the ice often pushed these plugs right out of their seats the same way frozen milk sometimes pushes the cap an inch or two above the bottle. As a result, they were misnamed freeze plugs and the name stayed with them. Technically, they're called core-hole plugs, since they're used to close the holes that result from casting the water passages inside the block. In today's light engines, they have little if any value as protection against damage caused by freezing."

Gus got back on the creeper. "I'll drive this new plug in place; then we can refill the cooling system. But this time I suggest you add a can of rust inhibitor to the water. It'll arrest corrosion in the other disks before they develop leaks."

"I think I'll take a little walk," Stan whispered to Gus. "I don't want to be around here when you hand Silas the bill for this little job."

"Just for that, you can give him the bill. Add \$3.50 for installing the freeze plug and a dollar for the inhibitor to the 75 cents he owes for the radiator repair." Gus hastily retreated to safety under the car.

Stan hadn't finished tallving the tab when Silas handed him a five-dollar bill and a shiny new quarter. The old gent was smiling.

"Wha—what's got into you?" Stan asked. "You almost look happy."

Gus finished installing the freeze plug and reappeared just as Barnstable, a picture of gracious dignity, replied, "Of course I'm happy. The other day I nearly had to buy a radiator for \$59. Today, I had my car expertly repaired for less than one-tenth that amount, and got an education to boot. Any day that I can save better than 90 percent is a very good day."

Gus and Stan exchanged glances, sighed, and threw up their hands.

Barnstable had scored again. ■ ■



Mercury's new sizzler the... *Marauder*

A new breed of scat!

Note the sleek, racy design of Mercury's newest hardtop: the 1963½ Marauder. Aerodynamic styling cuts air resistance, takes full advantage of Mercury's brilliant new V-8's.

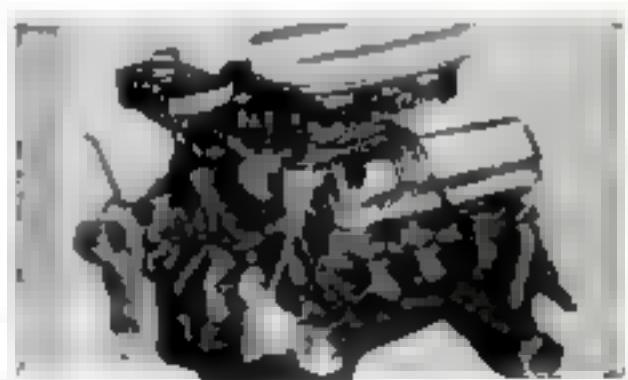
No matter which Mercury V-8 engine you choose, you get brilliant performance! A big 390V-8 is standard on the Marauder hardtop

model. On S-55 bucket-seaters, the standard engine is a 4-barrel Super Marauder 390V-8. Optional engines range up to a 427 V-8.

Marauder transmission choices include multi-drive Merc-O-Matic and 3- and 4-speed fully synchronized manual shifts. Looking for a top performer? See your Mercury dealer.

FACTS ON SUPER MARAUDER 427 V-8: Displacement: 427 cu. in. • 4.23 bore x 3.78 stroke • 425 hp @ 6000 rpm • 480 lb-ft torque @ 3700 rpm • dual 4-barrel carburetors • compression ratio 11.5:1 • mechanical valve lifters • fully synchronized 4-speed stick shift transmission.

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FOR 60 YEARS THE SYMBOL OF DEPENDABLE PRODUCTS



Infrared—Quick, New Home Cure for Cracked Asphalt

[Continued from page 170]

ways, it becomes an area patcher for holes up to 2' across.

Hot roller. This is a more specialized type of patcher. It combines an 18"-wide roller with an infrared burner. The burner heats the roller, which in turn heats the asphalt. The roller is ideal where repair areas are large—a big driveway, tennis court, or patio floor. But since the roller's burner warms the asphalt indirectly, it doesn't work a cure quite as fast as patchers that apply heat directly.

Once fused, cracks should stay sealed for the lifetime of your asphalt. Old subsurface problems may cause new cracks, but seldom do they reopen a crack that's sealed by infrared. Moreover, neither rainy nor freezing weather will stop you from using a patcher, as it often does with other asphalt-repair methods. Infrared rays dry out potholes, thaw ice-filled cracks, and are fully as effective in wet weather as in dry, winter or summer.

Repairing cracks. Short-run, hairline cracks ($\frac{1}{8}$ " or narrower) need be heated only a $\frac{1}{8}$ " or so deep. The cure is quick and easy: Simply set a narrow-width crack-fuser over the crack and hold the burner a few inches above it. When the asphalt begins to fume and appears to be crawling, the patcher is removed. The softened asphalt is then screeded level with a board and rolled or tamped smooth. And that's that.

Wider cracks should be opened up with a chisel or screwdriver and new dry-mix asphalt (the kind that comes bagged and ready to use) worked into the opening. First, enlarge the crack to about twice its original width. Then rake and tamp in the dry mix. Screeed the new mix even with the surrounding asphalt. Tamp it once more. Finally, administer the infrared treatment.

The rays bond the old asphalt with the new and make a smooth, permanent repair. Usually one to two minutes' heat over a filled crack is enough. The repaired crack may at first appear blacker than the surrounding, weathered surface, but it will gradually blend with the rest in three to six months. There's no need to uproot weeds and grass first since the patcher will burn them out for you.

Repairing potholes. These take a bit more doing because the area is larger and

you'll need to do more careful filling. Select a patcher whose burner area (actual burner dimensions) is large enough to cover the pothole completely. You can repair a pothole with a smaller patcher by making several passes over it, but you'll find that heating it in sections makes screeding and leveling more difficult. It's a lot easier to use a machine that will cover the whole damaged area at one time.

Potholes vary considerably in depth. Some are merely surface depressions, while others, long neglected, may reach clear to subsoil. Shallow holes—less than 2" deep—are no problem. Simply fill them level with new dry-mix asphalt, tamp, and apply the patcher. Be sure that the filled spot is level with the surrounding surface after the fusing and final tamping. You may find that the softened asphalt has settled somewhat under the tamping. In this case, spread on some additional dry-mix asphalt and repeat the fusing.

Holes deeper than 2" take more care because the patcher's heat penetration is limited to about 2". Here, the filling must be done in stages, a layer at a time. Each layer should be no thicker than 2" and should be thoroughly tamped and fused before you add the next layer. If you do all the filling at one time, you'll merely fuse the top 2" and the material underneath may settle later and cause a new break. For the same reason, whenever a hole goes all the way down to the ground, the soil or rock base should first be firmly compacted.

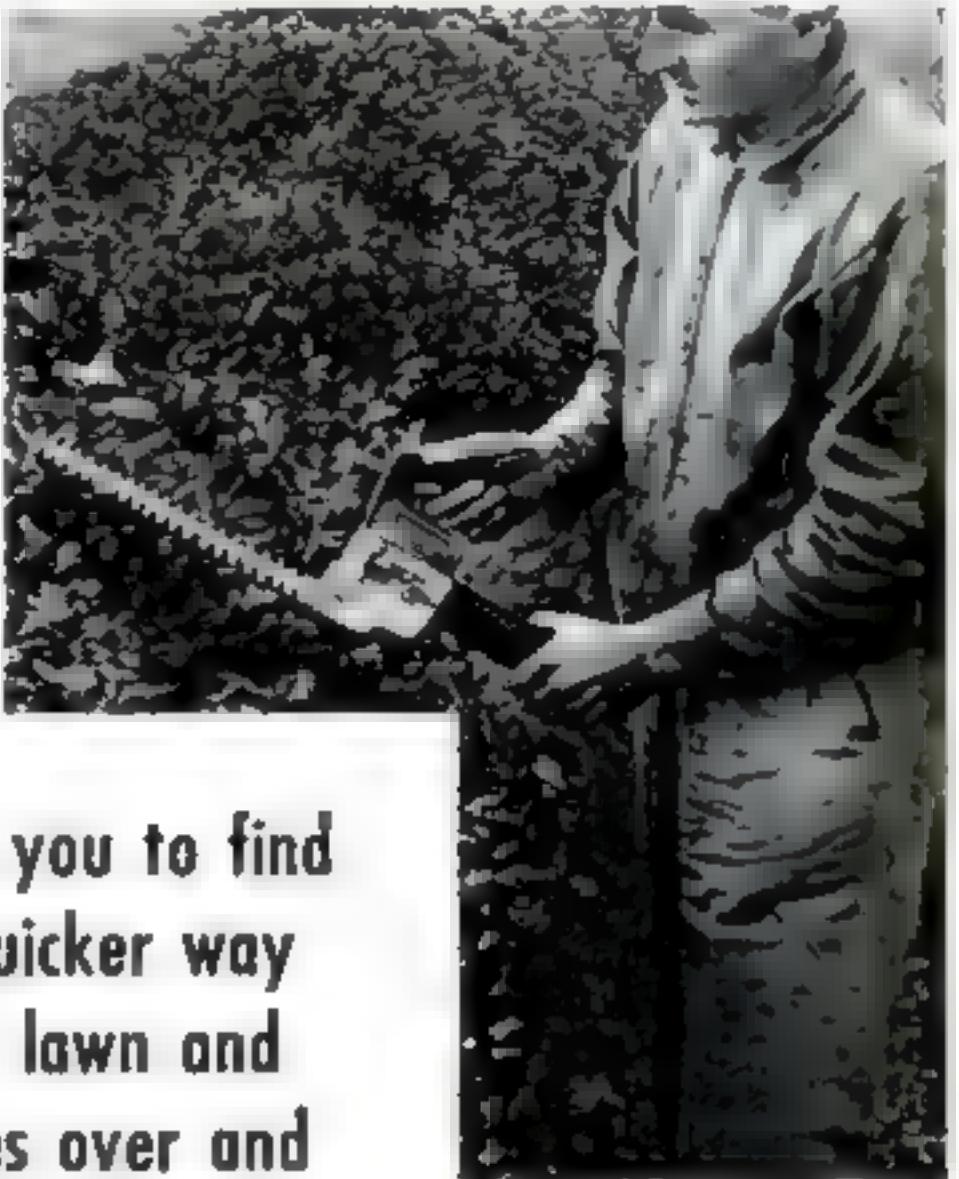
Leveling humps. High spots in an asphalt drive, while not as objectionable as holes, cause rain water to pool and disrupt the driveway's built-in drainage pattern.

To knock down high places, heat them with a large area-type patcher until the asphalt is soft, then trowel or screed off the melted asphalt level with the surrounding surface. Compact the area and reheat it to fuse the repair permanently. On very high humps, you may have to be careful not to thin the asphalt surface too much or go all the way through it by scooping off the top. In this case, it may be necessary to remove all the asphalt first and level off the hump under it before putting down a new asphalt surface. As in patching potholes, it's best not to attempt a surfacing job that's bigger than the patcher can handle at one time. ■ ■

TRIMS TRIMMING TIME! In corded products, two B&D Hedge Trimmers, each cuts a 13" swath in a sweep of your arm. Light, easy one-hand control to reach the tough spots. Right or left hand auxiliary handles. Powerful, air-cooled motors.



CORDLESS, OF COURSE! World's first, B&D's Cordless Hedge Trimmer has nickel cadmium Power Pack in handle that delivers enough power to trim an average hedge 3 feet high and 200 feet long! No cords, generators! Recharge overnight.



We challenge you to find
an easier, quicker way
to get your lawn and
garden chores over and
done with this weekend.



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MAKER OF THE WORLD'S FIRST CORDLESS POWER TOOLS

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two 16-column rings: an inner ring 47 feet in diameter, and an outer ring, of diamond-shaped columns, 109 feet in diameter. Sixteen reinforced-concrete beams span from the inner core across the inner ring of columns to the outer ring. Ramps and balconies extend 10 feet beyond the other columns to give each tower a total outside diameter of 128 feet.

Climbing cranes. The Linden crane used atop the core of each tower was invented eight years ago by Ellis Linden of Västeras, Sweden, and first used in this country in 1960. The model used at Marina City weighed 18 tons, had a radius of 95 feet, a capacity of 8,000 pounds, and cost \$35,000. The base of the crane rested on an interior floor of the core, usually two or three floors below actual construction, with shores down an additional four floors. According to Bertold Weinberg, resident engineer, the crane made possible a concrete-construction cycle, in each tower, of a floor a day on the core walls, half a floor every day on the parking ramps, and a full floor every other day for apartment floors.

On the Marina City project the interest on money invested in real estate and development was said to amount to \$500 a day. Time was costly, and the contractor, James McHugh Construction Co., worked out a carefully detailed 48-hour construction cycle that resulted in substantial savings.

With the schedule calling for one apartment floor every day in one tower, construction crews performed the same tasks every day at the same time—one day at one tower, the next day at the other.

Concreting started at six a.m. By noon, surveyors laid out the next floor on the new concrete. At two p.m., ironworkers began erecting reinforcing steel. Concreting was done by four. At five, carpenters came on, followed during the night by electrical-layout crews and ironworkers. At six a.m., another electrical crew did piping work and ironworkers reinforced the slab, and concreting of columns and slabs for the next floor would begin. It took time to work all the crews into the cycle, but once achieved, the schedule was maintained regularly for more than three months with only occasional delays caused by weather.

Saving time and money. The use of fiber-glass forms for walls, columns, beams, and slabs proved to be economical in mate-

rial cost—\$4 to \$5 per square foot for core forms, \$1 per square foot for slab forms (because they were re-used many times). Core forms 9 feet high (for floor-to-ceiling heights of 8½ feet) were re-used 67 times—until the cores were topped out. Fiber-glass also cut labor costs. The forms could be handled easily in large, lightweight sections and required simplified shoring. They impart such a smooth, flawless surface that much of the concrete in Marina City is left exposed.

Crushed-stone concrete was used in all the vertical members, columns, and walls. Lightweight concrete was used for all horizontal framing, beams, and five-inch-thick floors of ramps and apartments. With standard concrete, thicker slabs and beams would have been necessary, and the added dead weight would have required bigger beams, columns, and caissons. Conventional steel framing, with suspended ceilings, might have called for as much as 18 inches more in floor-to-floor heights. With 60 floors, that would have added 90 feet to the overall height of each tower, and would have involved the added cost of 60 feet more of window wall, 90 feet of plumbing lines and elevator travel, plus larger caissons and bigger pumps to raise water to the top floors. Lightweight concrete and the elimination of ductwork made possible 60 stories with a height that usually yields 40 stories when steel framing is used.

Marina City set a record as the world's tallest reinforced-concrete structure (588 feet, not including its 437-foot TV broadcasting antenna), and it has also set some precedents. New residential building projects have followed its lead to the long-neglected downtown area of Chicago, and both Detroit and Denver want Goldberg to design a similar round city-within-a-city as a step in restoring their downtown areas.

When Goldberg described to his mother-in-law the central-city planning he envisioned in Marina City, he went through a lengthy explanation. She listened, then summed it up brightly. "Oh, that's what we used to call 'living above the store!'"

The first eager tenants moved into Marina City last October before floors above and below them were finished. The entire project will be completed late this summer and all apartments occupied, confirming Goldberg's belief that people want to "live above the store"—if they can do it in style. ■ ■



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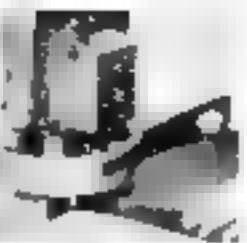
Router



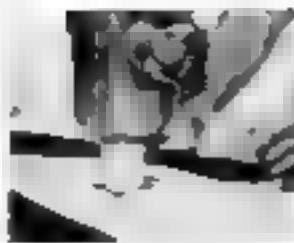
Drum Sander



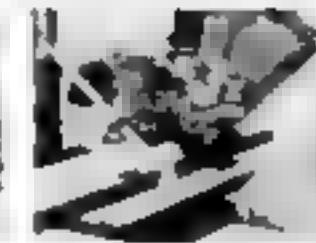
Radial Power Saw



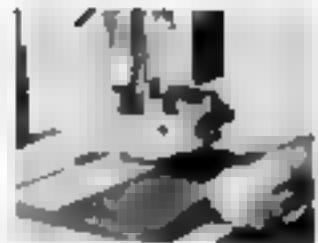
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Does Your Handwriting Give You Away?

[Continued from page 106]

(writing) motions. . . . The manic depressive has an exaggerated size and direction, moves slowly and rhythmically. The schizophrenic shows a severe conflict between the contracting and releasing writing strokes . . . resulting in a deteriorated rhythm."

Perl, former chief clinical psychologist at the Army's Fort Leavenworth disciplinary barracks, also maintains that handwriting is valuable in judging emotional stability, impulsiveness, and aggression.

Psychologist Thea Stein Lewinson, former researcher at New York's Psychiatric Institute and now graphological consultant to St. Elizabeth's Hospital in Washington, D.C., affirms that paranoia, schizophrenia, and other mental ills show up in handwriting months, even years, before obvious clinical signs.

Physical ills. Sickness leaves its mark on handwriting, too, according to a recent article by psychiatrist and neurologist W. G. Eliasberg in the medical magazine *Geriatrics*. Harry O. Teltscher, handwriting consultant to the War Department's Military Intelligence Division during World War II, agrees.

"Brain tissue is especially sensitive to any lowering of oxygen," states Teltscher, now a practicing psychologist. "Heart disease, circulatory ailments, tumors—any physiological condition which changes the amount of oxygen the brain gets—will influence handwriting in a special way and give an early record of pathological dangers."

The most astounding claim of diagnostic graphology is that it detects cancer. After three decades of research, graphologist Alfred Kanfer says he has proved that cancer changes writing. Kanfer, now a research assistant at New York's Handwriting Institute, Inc., a foundation studying graphology, explains his extraordinary findings this way:

"For some reason—no one knows if it's a toxin, a chemical, or something called host reactions—cancer distorts microscopically fine portions of the writing in a special pattern. Find this pattern and you've spotted cancer."

Though Kanfer has had no formal medical training, the New York Hospital for Joint Diseases, private benefactors, and several insurance companies were impressed enough with his work to finance his research and

supply writing samples of tens of thousands of cancer patients. Statistics published in 1958 indicated the test had an 80-90-percent accuracy, and was even more effective when the patient was under 60.

False hypotheses? Kanfer has his critics, too. Many cancer researchers say his studies aren't conclusive, that he's working under false hypotheses and that his methods aren't scientific. The question may be settled once and for all when New York's Memorial Hospital for Cancer and Allied Diseases publishes a near-finished report dealing with the latest findings on the Kanfer test.

Though the Memorial Hospital report may soon decide Kanfer's claims, other handwriting analysts have plenty of objections to answer before they've proved their point. Albert Osborn, one of the country's leading handwriting-identification experts and examiner of forged documents, raises this criticism.

"Handwriting analysts assert that vertical writing indicates something about personality," says Osborn. "Yet, for 15 years vertical writing was taught in our schools and probably over 150 million people learned to write that way. Vertical writing and other traits indicate school training, not character."

Dr. James H. Ricks of The Psychological Corporation in New York City comments: "Handwriting is a form of behavior and as such may reveal general characteristics of a person. Usually, however, these are obvious characteristics that can be easily observed other ways. Graphologists' claims to assess subtle qualities like honesty or determination have not been supported by the kind of critical test customarily given to other psychological measurement methods."

Other foes of graphology hold that analysts try to meet the subject and get insights into his personality from his movements, way of dressing, and manner of speaking, and that the wording of a "character analysis" is usually so vague that it would fit anybody.

For the defense. Handwriting analysts have reasonable-sounding answers to most objections. But there's one criticism they admit they're hard pressed to answer: Where is the scientific proof that graphology really works?

"Sure, handwriting tells *something*," says Dr. James Farr, psychological consultant to



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Does Your Handwriting Give You Away?

management and industry. "A person who's excited will write more illegibly than when he's calm. But there's no proof that someone's writing expresses his complete personality."

Graphologists have long verified their claims by empirical evidence—i.e., proof by case history. In 1860 a French priest, Abbé Michon, became interested in handwriting and personality. He collected hundreds of writing samples from people who were known to have such character traits as courage, honesty, deceit, etc., in common. After studying these samples, Michon found that each group made a similar writing sign or combination of signs such as wide letters, large loops, or high T bars. He concluded that these writing signs in his control groups were caused by their common personality characteristic, assumed that they indicated this personality trait for everybody, catalogued hundreds of such writing signs—and launched handwriting analysis.

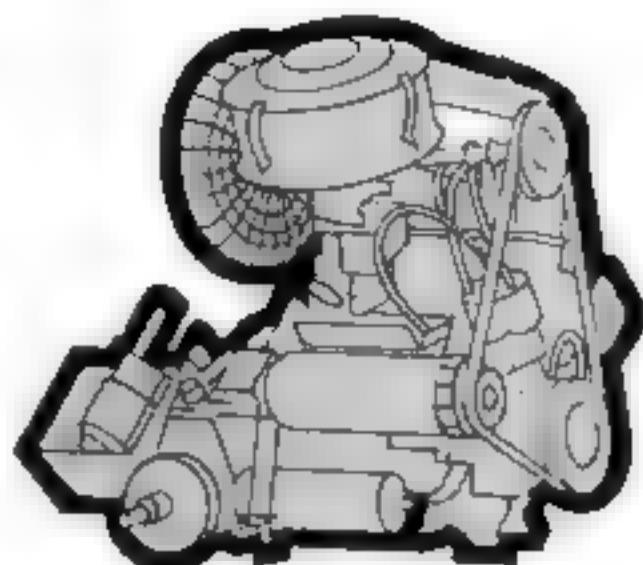
Since then, Michon's followers have collected enough evidence in support of his theory to make graphology a respected science in Europe. Many universities, including the Sorbonne, the University of Hamburg, and the University of Zurich, teach graphology. Often, it's admitted as evidence in court cases.

But most American psychologists aren't satisfied. They want proof that handwriting analysis is a science, not just educated guess-work.

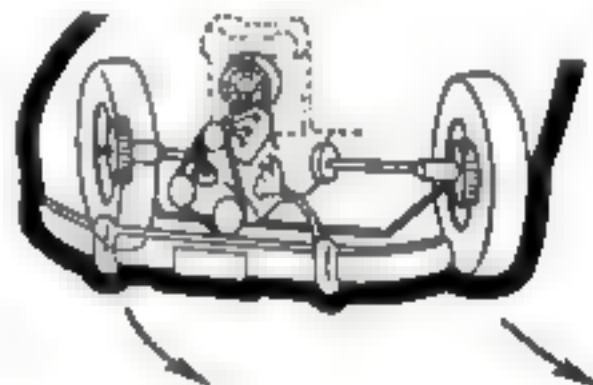
A license for graphologists? Graphologists admit that graphology teems with frauds. They are trying to clean house, establish licensing systems such as European countries have. A handwriting analyst, they say, must have years of training in psychology or psychiatry, and they become livid when confronted with a book purporting to teach handwriting analysis in 10 easy lessons. "Practicing graphology after reading one of these books," a handwriting expert told me, "is like attempting surgery after skimming through a first-aid pamphlet."

What does graphology's future look like? Right now, more young psychologists than ever are studying and doing research in it. For many older psychologists, cautious curiosity has replaced scorn. But it will probably be some years before we know whether graphology will prove itself, or go down as another dud that fell by the scientific way-side. ■■

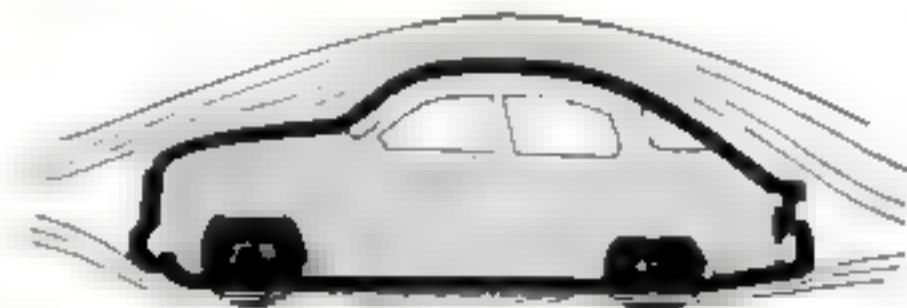
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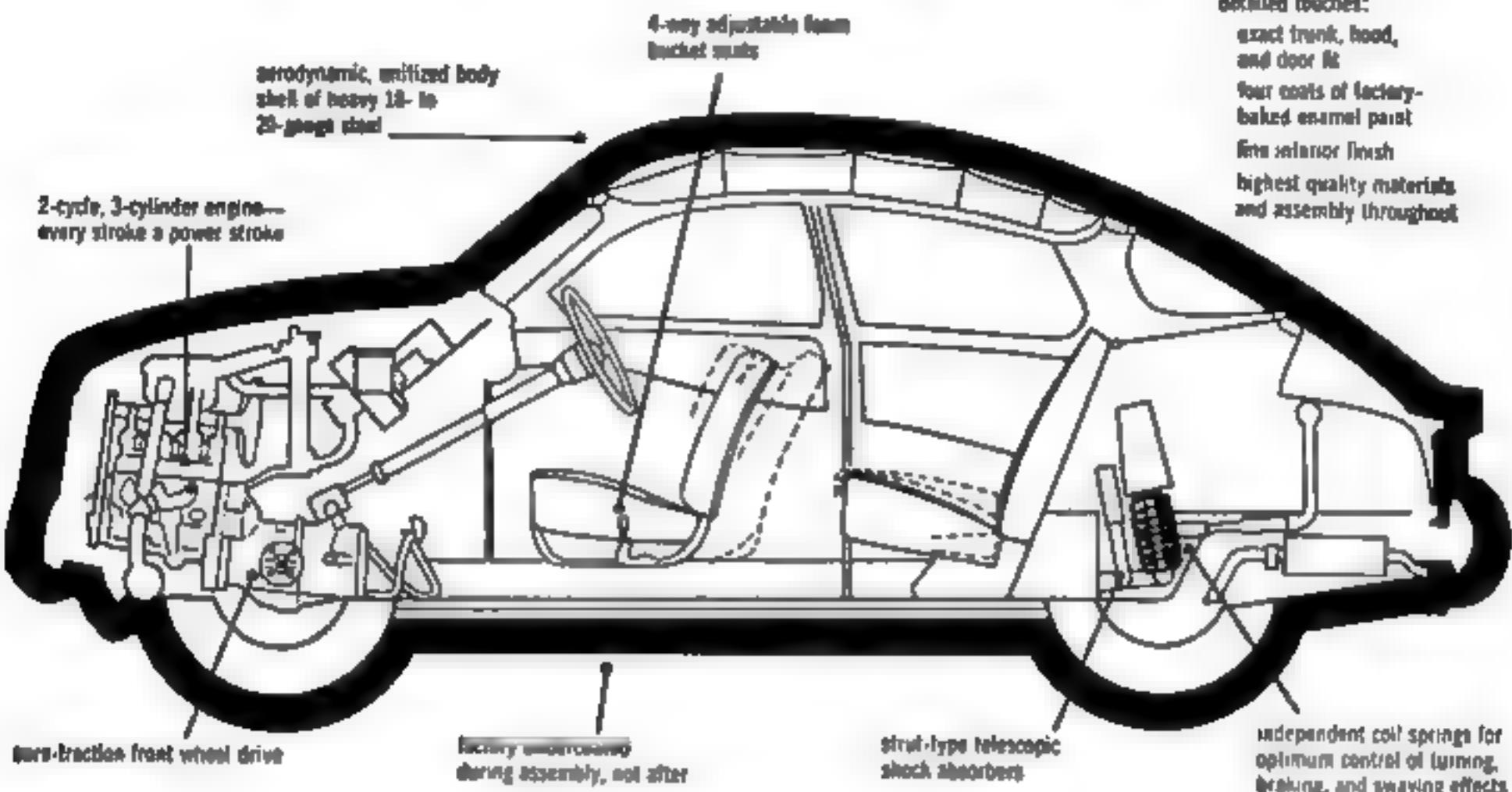


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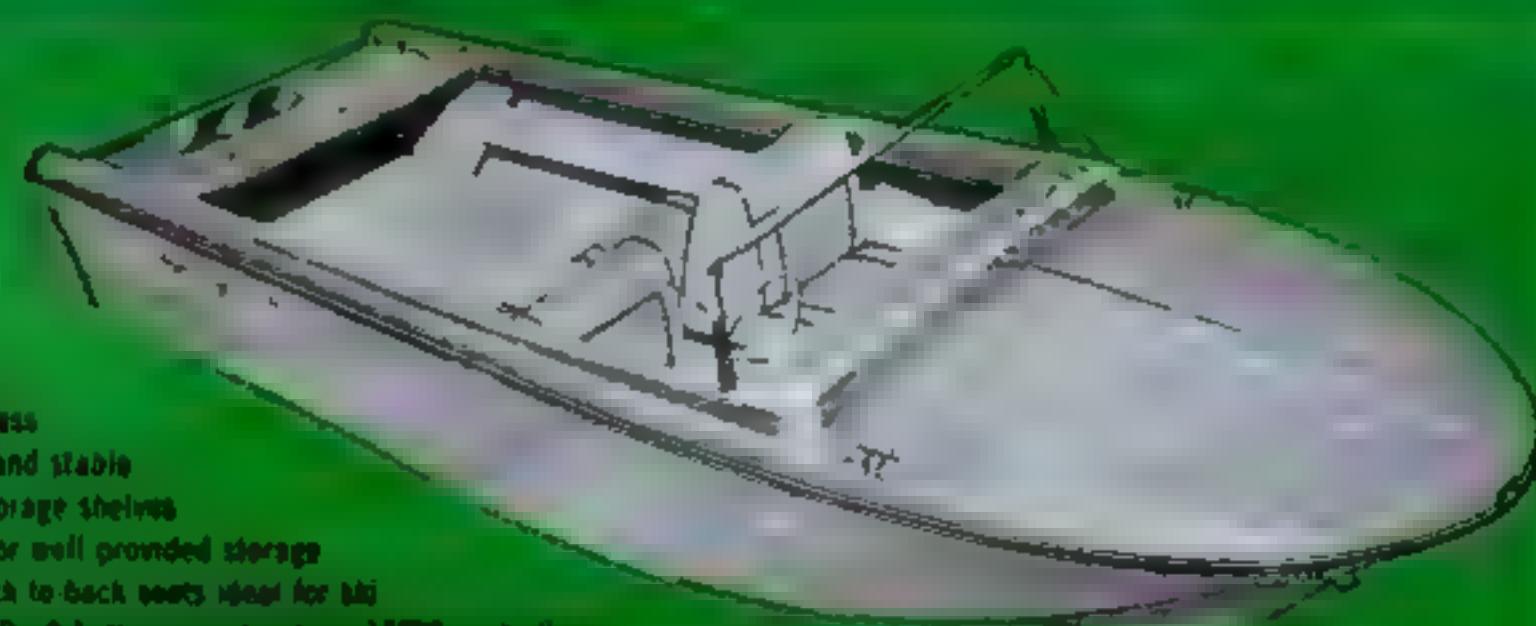
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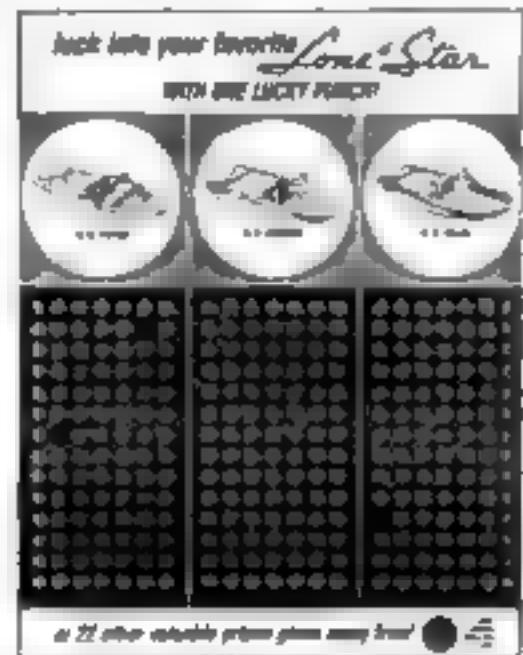
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unit was the only model available. Some users still prefer them. But operating costs are higher; average battery life is from 75 to 100 hours. A word of caution: Don't buy a model that requires nonstandard batteries. You'll spend too much time chasing down replacements.

Military surplus detectors? My advice is: Don't buy them. Batteries are often of special size and construction; to adapt the detectors to standard batteries, modification is necessary. Also, the military units—designed for mine detection—were made to locate large masses of metal. Those who've used them consistently say they aren't worth a hoot on small objects near the surface. Perhaps the biggest drawback is sheer size and weight.

The single advantage seems to be price. I've seen them advertised as low as \$30 to \$40. But this kind of economy can be expensive.

Business or hobby? Don't buy a detector expecting quick, rich rewards. View it as recreation. If you do find a buried bonanza, it's a bonus.

The first question is where to look. This depends on where you live. But wherever you are, there's good hunting close by. The difference among areas is chiefly in the types of objects you can find. For example, in the West (where I live) there's always a clutch of abandoned ghost towns within three or four hours' drive; also, old mining camps, crumbling stone houses, adobe ruins, and historically interesting sites.

What have I found? Not counting tin cans, foil wrappers, and bottle caps, I've unearthed a fair collection of blacksmith tools, iron pots, and assorted objects too old to identify.

An enthusiast I know, who lives at Huntington Beach, Calif., travels the dawn tidelines every morning crouched over his detector. He carries a long-handled scoop-screener. When he gets a reading, he scoops up sand in the screen and lets it sift through. The object remains. He's got boxes full of old pennies—most of them worth at least a quarter. He finds an occasional watch, jewelry, rings. He's found diamond rings appraised as high as \$2,500. Often he's hired to find a lost family heirloom.

In the East, Civil War battlefields get a lot of attention from detector users. One fellow reports he's been so successful in

finding old belt buckles, gun parts, and regimental insignia that other hunters follow him on the sly. He has to backtrack, and turn down alleys, over hills, and through ravines to reach his favorite hunting ground alone. It's standard procedure for him to camouflage his car with brush while he hunts.

The most successful hunters—those who find really valuable objects—study their areas. They pore over old maps, town records, tax assessments, old newspaper accounts, and historical books. Pinpointing the precise location of an old hotel, a stage-line office, or Wells Fargo stop is a big advantage.

Years ago, travelers took along their valuables. They often stashed the stuff under the floorboards of their hotel rooms or buried it in open country.

Abandoned homesites are good hunting. Many a recluse has died alone, leaving thousands of dollars hidden in walls, attic, or basement. Many used metal containers.

But remember to stay out of state and national parks with your detector. A stiff fine may be imposed for digging in these locations, and your detector may be confiscated. On private lands, come to an agreement with the owner before hunting. The average split is 50-50, but negotiate any reasonable deal. If you make a find before asking permission, he'll descend on you with the law and likely take it all!

The hunt begins. The proper way to work a detector is with the head held a few inches from the ground. Work the area thoroughly in a definite pattern. Hold the detector head the same distance from the surface at all times. This avoids false readings caused by lifting and lowering the head as you walk. Walk slowly, since very small objects such as rings and single coins barely flutter the needle.

At peak sensitivity, the detector has the shortest range. When it's adjusted for maximum depth, small objects are hard to locate, but large objects down deep show up well. On the theory that most valuable items are buried a foot or less, most users adjust for maximum sensitivity.

There is no way to tell what you've spotted with the scope without digging. But the electronic wizardry of the detector will give you a big edge in any treasure hunt.



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Should You Change Your Job?

[Continued on page 111]

spare time, at your own pace. More than 300 subjects are offered: aeronautics, air conditioning, automation, computers, construction, electronics, foremanship, gas engines, instrumentation, mathematics, radar, surveying and mapping, tool design and toolmaking, welding, wiring, woodworking, and so on. You can get a list of accredited schools from the National Home Study Council, 2000 K St. N. W., Washington 6, D.C. (Some reputable schools, however, have not requested accreditation.)

Studying at home demands sustained will power, but if you stick with it, you do get ahead. POPULAR SCIENCE's own survey [see "Plain Facts about Correspondence Schools," Feb. and March, 1958] showed that almost everyone who finished his course got raises or promotions or both. In my own town, a man who had been working in a nearby factory studied drafting in his spare time; he doubled his pay. In Texas a toolmaker completed his course and was made foreman. In Maine a loom fixer studied to be a supervisor and won the promotion. An Illinois printer, fearing the results of technological change, studied business management; instead of moving out, he moved up—to become assistant to the vice-president.

Don't overlook technical institutes. They offer classroom and laboratory instruction—often at night—for engineering aides, lab assistants, draftsmen, electronic technicians, auto mechanics, and many others. Similar courses are given by junior colleges and universities in many cities. You can get a list of accredited technical-institute programs from the Engineers' Council for Professional Development, 345 E. 47th St., New York 17, N.Y. (It costs 25 cents.)

Vocational high schools often offer adult training at night. Your county superintendent of schools can refer you to one near you. At the Bergen County Vocational and Technical High School, Hackensack, N.J., eight jobs are available to every graduate, says the principal.

You may even be able to get free training (plus a living allowance) through such government plans as the New Manpower Development and Training Act. On this, check with your local state employment office; it decides what skills are needed in your area and selects the men to be schooled in them. You do not have to be out of work to qualify. This program alone is set to up-

grade several hundred thousand people during the next three years.

And unions—faced with more calls for skilled workers than they can fill—are pushing apprentice programs. The International Brotherhood of Boilermakers (150,000 members) just this year called on International Correspondence Schools to help. Apprentices must now complete a 600-hour, four-year home-study course before they advance to journeyman.

Count your talents

Before diving into any course, no matter how glorious its promised future, make sure you are fitted for the work. You'll get some counsel from the schools. Many check on aptitude before accepting trainees. You can probably tell even better by examining yourself critically:

- What did you do best—and like best—in school? Math ability is basic to the computer field. If shop was your favorite, there are auto repair, welding, toolmaking. If you were good in English and science, technical editing is a booming profession.

- How about jobs you worked at? Your past experience is a solid clue to what you should try for—or stay away from.

- And hobbies? This country is full of auto mechanics, TV servicemen, and craftsmen who transformed home workbenches into profitable careers.

But a surprising number of people possess talents that lie hidden. Take Ralph Hanlon in Kansas City. He had been unhappy in a whole string of clerical jobs. No wonder. His natural bent, aptitude tests revealed, was for carpentry or cabinetmaking.

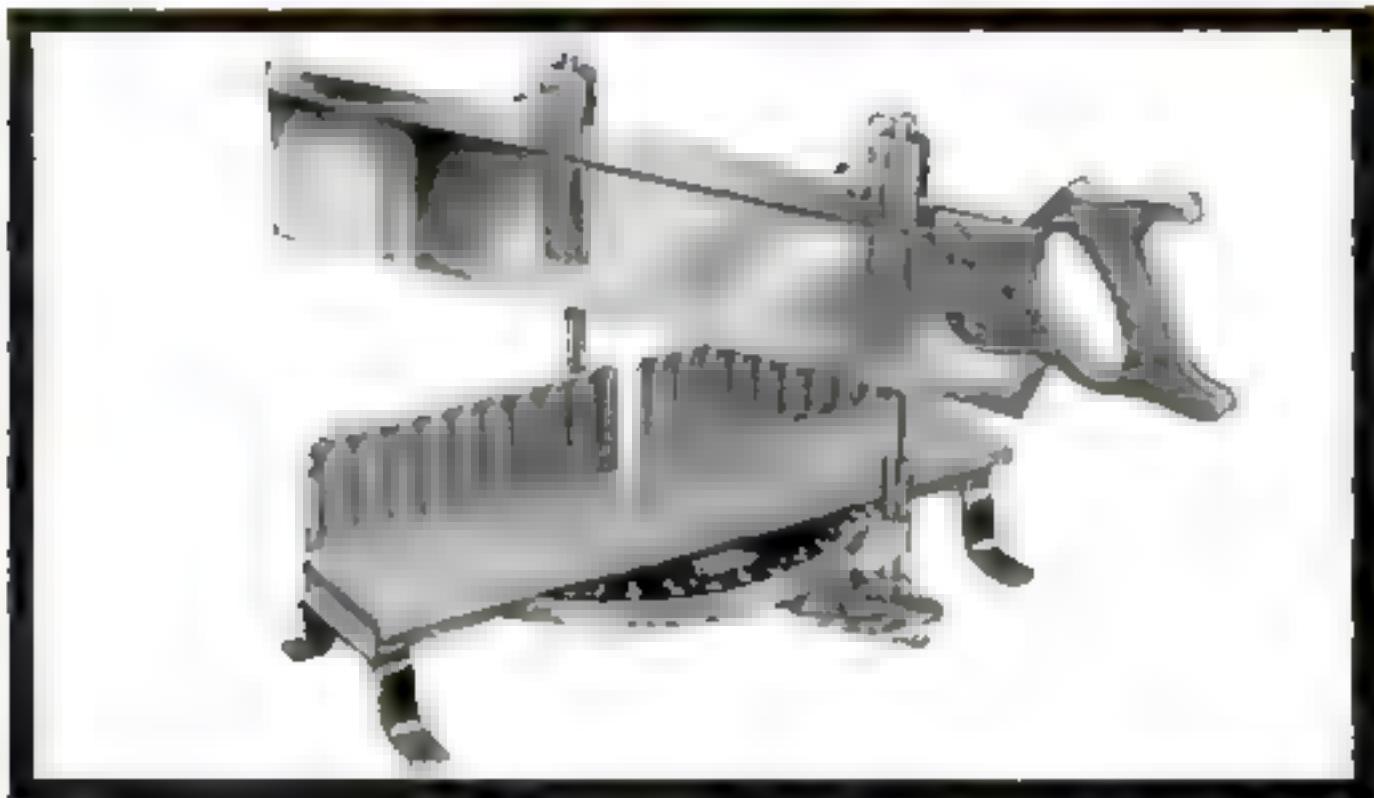
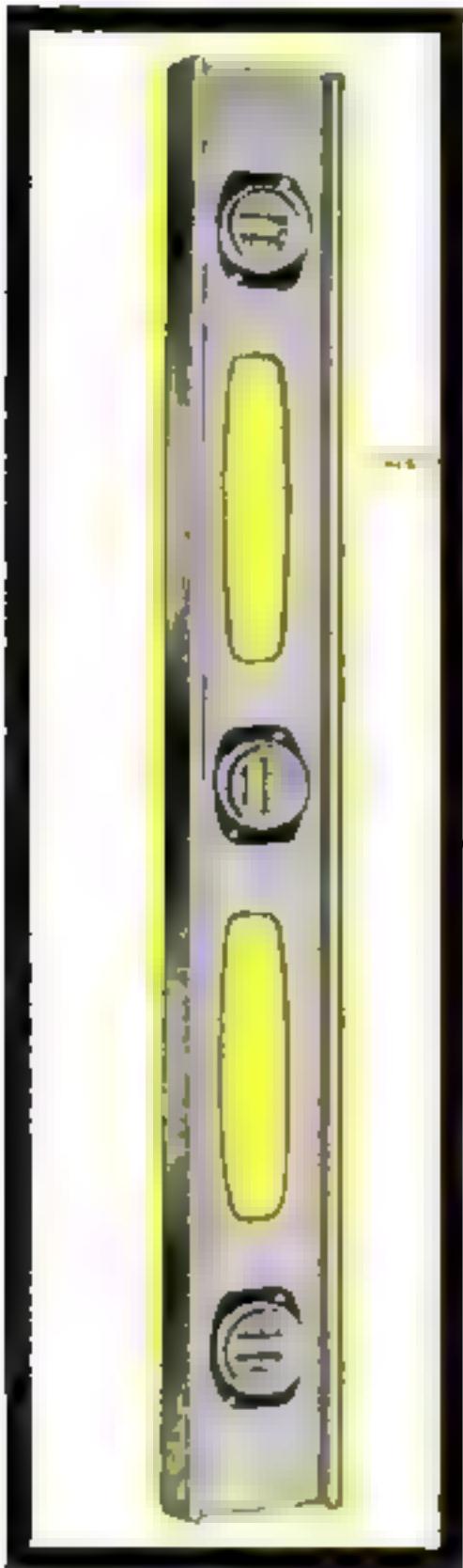
To find out if you are hiding your light under a bushel, get expert guidance. Call on the counselors in the local office of your state employment service. Ask the principal of your high school—he can tell you the results of formal aptitude tests given you when you were a student. Or he may suggest a professional agency that (for a fee) will run you through a battery of talent-analyzing psychological examinations.

A lot of work? It is. And it's worth it.

In every section of the country, exciting, high-paying jobs are going begging right now. In the coming years, millions of brand-new jobs will open up. They will go to the men who know where to look for them—and are prepared to fill them. ■ ■

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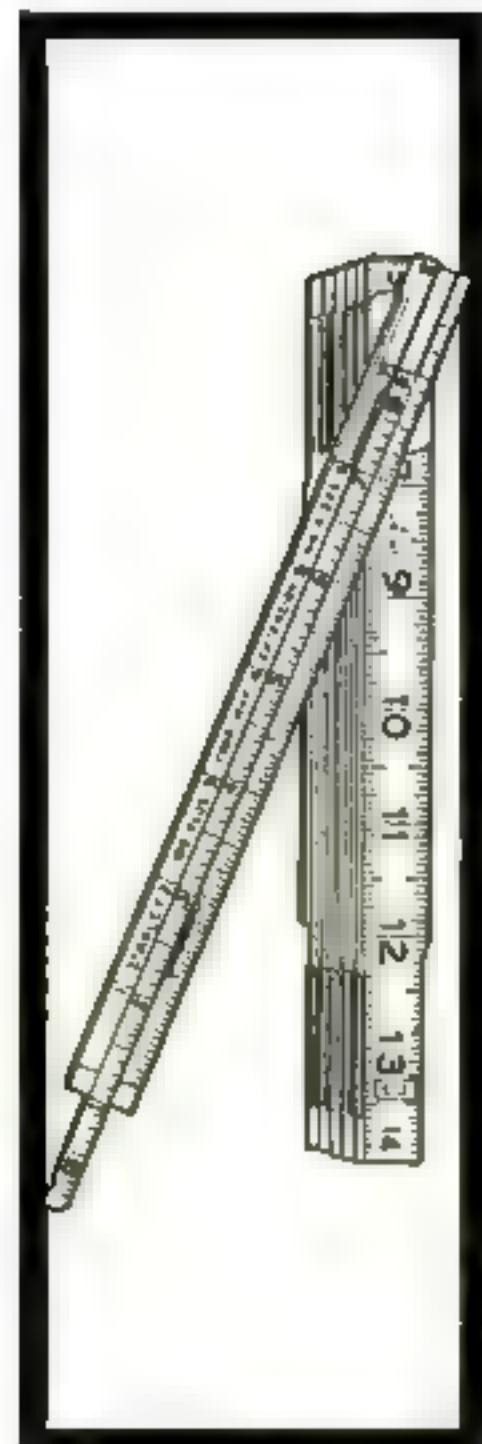
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smidgen of other elements—a representative sample of the solar material.

The sun's powerful ultraviolet radiation ionizes the atoms of this matter, stripping the electron shells from their nuclei. So the wind is an outward streaming of subatomic particles—electrons, protons (the nuclei of hydrogen atoms), and the nuclei of other elements.

These electrically charged particles spiral around the lines of force of the sun's radial magnetic field, which may extend as far as the orbit of Jupiter. But the particles are traveling at "supersonic" velocities—faster than kinks or compressions of a magnetic field, which are the outer-space equivalent of sound waves. So the solar gusts actually carry loops of the sun's magnetic field along with them, and pile up shock waves in space.

"How much matter is actually being thrown out by the sun?" I asked.

Dr. Van Allen did a few calculations. "Hmm, that's quite a bit," he said. "I never really thought about it before. Roughly 400,000 tons a second. That's being cast out in all directions, of course."

"And how fast is the wind blowing?"

"About three million miles per hour," he said. "But that may be its top speed. We don't really know how it varies yet."

"Then the earth is really moving through the sun's atmosphere?" I said.

"Yes, but that's torturing the word 'atmosphere' a bit. The earth's atmosphere is captive gas. The solar wind is material being thrown out so fast that it's escaping from the sun's gravitational field."

"Is the material of the solar wind and the radiation belts the same thing as plasma?"

"Yes, it is plasma, the fourth state of matter—gas in which the atoms have been broken into charged particles."

"Now that we know that space is not empty, is it fair to say that plasma is what space is full of?"

"It's not full in the sense that it couldn't hold some more," said Dr. Van Allen. "But plasma is what largely occupies solar space. Of course there are other things out there—dust, gas that's not ionized (in interstellar space), cosmic rays and other specialized particles, electromagnetic radiation such as radio waves and light waves, electric currents, and other energy manifestations, like gravitational and magnetic fields."

"What about heat?" I said. "Is space really cold?"

"Well, there are several ways of thinking about temperature," he said. "The Mariner spacecraft, as it approached Venus, had an equilibrium temperature close to the boiling point of water; it absorbed heat from the sun and reradiated much of it again. But in terms of the average kinetic velocity of the particles, the temperature of the plasma near the earth is about a million degrees. You wouldn't feel it if you were out there in a space suit, because relatively few particles would bump into you. The matter is very sparse—100 to 1,000 particles per cubic inch, compared with about 330 billion billion molecules per cubic inch in the air at sea level."

It's a strange wind that blows hot and cold at the same time, I thought. "Can the conditions of space be compared to anything we're more familiar with on earth?"

"Yes, I think so," said Dr. Van Allen. "You see, in inventing electron tubes and other devices involving vacuums and plasmas, in exploring ionization and various magnetic effects in the laboratory, we've accidentally stumbled on many of the conditions that exist naturally in space."

"Then what would be the best model of space conditions?"

"To me, the closest thing would be the beam of accelerated particles in a cyclotron. However, the material is not as thinly distributed as in space."

"An atom smasher may be familiar to you, as a physicist," I said. "But it's not to the average person. How about the environment in a TV picture tube? There's an electron beam there, and it's aimed by magnetic fields."

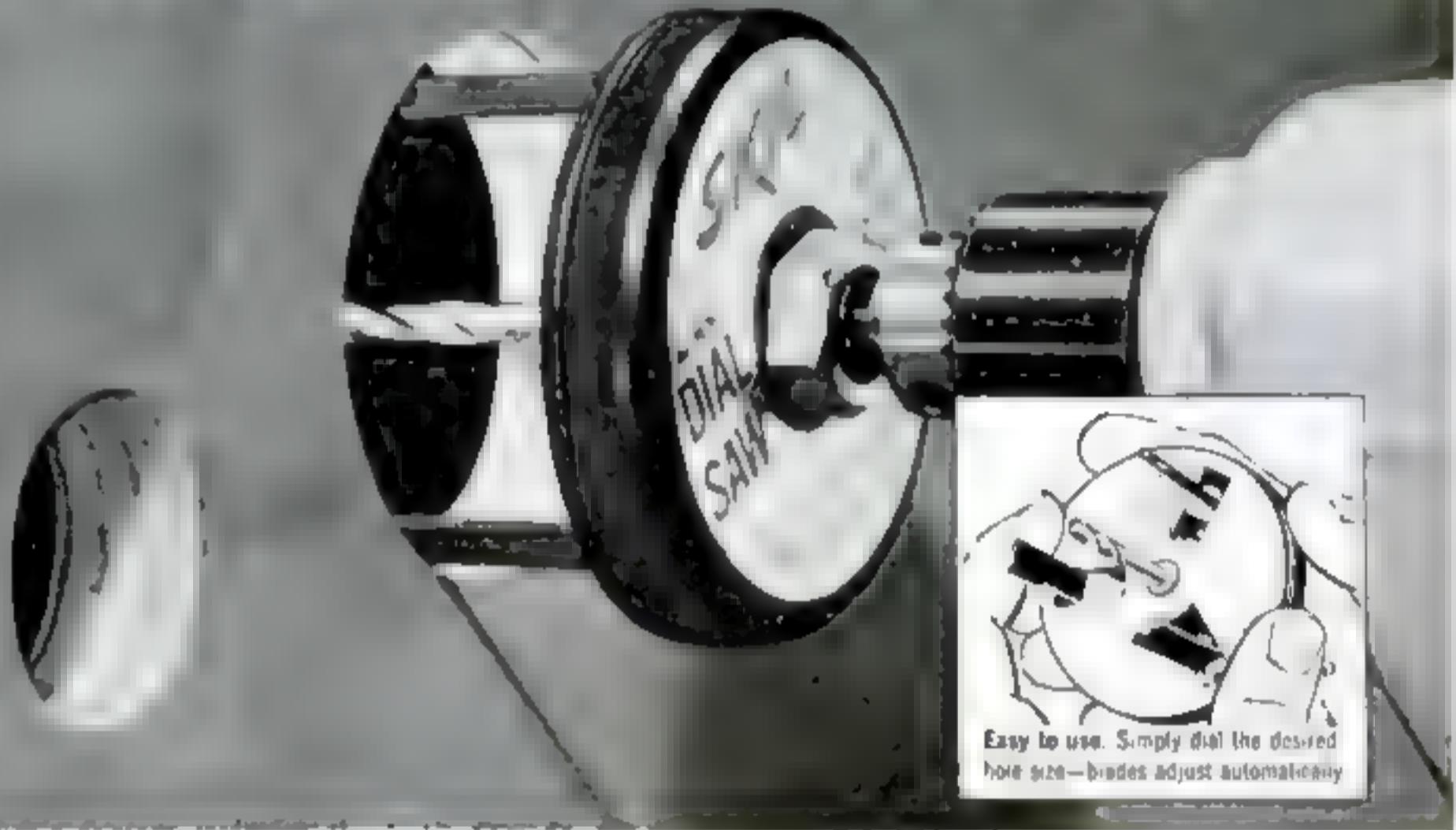
"Yes, but again the plasma is thinner in space, and the energies are much higher. A cyclotron is the best example, because it gives you an analogy with what happens near the earth, as the solar wind interacts with the earth's magnetosphere."

"I meant to ask you about that," I said. "How do the particles get into the Van Allen belts?"

Dr. Van Allen laughed; apparently there's a controversy on that subject right now. "We wish we knew," he said. "There are various explanations, but they're what I call hand-waving arguments. You have to talk very fast and wave your hands around,

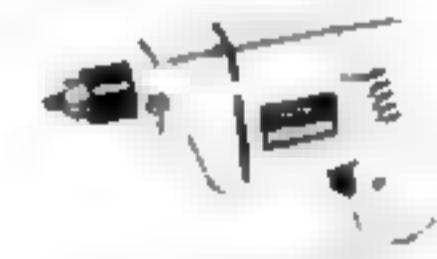
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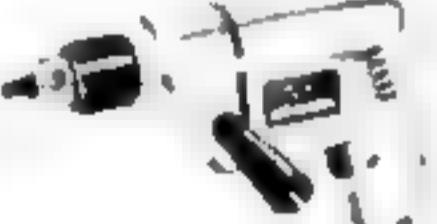


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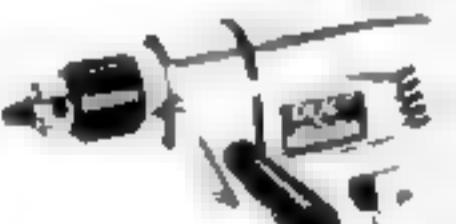
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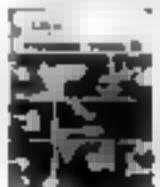
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Van Allen Tells What Space Is Like
or somebody might ask a question and demolish your argument.

"We know that the particles coming from the sun don't have as much energy as the particles in the radiation belts, so the earth's magnetic field must act as an accelerator. But a static magnetic field won't do that. The source of power has to be the solar wind.

"This 'supersonic' wind creates a shock wave where it encounters the earth's magnetosphere, and the earth's field is compressed as the solar gas flows around it. At the same time, the earth's magnetic field repels the solar field, and electric currents are induced in the plasma. So the solar wind wiggles the magnetosphere, and as particles leak into the radiation belts they get pumped up to high energies."

"Then this mechanism is what makes the particles in the Van Allen belts a hazard to space travel?" I said.

"That's right," he said. "The particles in solar wind itself won't even go through a piece of tissue paper."

"Where do solar flares fit into the picture?" I asked. "I understand they are dangerous."

"Flares are the storms of solar space. They're tongues of plasma that occasionally shoot out from the sun, with energies much higher than the normal wind. For example, the biggest flare yet recorded, in September, 1960, would have delivered about 700 roentgens to an unprotected man in space, over two or three days. That's easily enough to kill a man."

"Then astronauts will have to be shielded against these flares?" I said.

"Yes, that's one possibility. But shielding costs weight, and we may not be able to afford it. The other possibility is to schedule flights at times when it's unlikely that an astronaut would receive too much radiation from flares."

"We can't predict the weather very well here on earth," I said. "How good are we at predicting it on the sun?"

"Well, we're learning," he said. "Bubbly, active regions on the surface of the sun seem to show up a few days before flares occur. So it's possible to make some general, prudential predictions. We can forecast for a period of one to two days. That's not good enough, but we hope to improve our accuracy by the time we're ready to send astronauts to the moon." ■ ■

Slow Drivers Can Kill You
[Continued from page 79]

The Columbia researchers apply the same reasoning to some classes of aggressive drivers. One check of the research results was a study of city taxi drivers who had had no major accidents—despite the roughest kind of exposure. The outcome was surprising. For the study suggested that they were lacking in the attribute that ordinarily distinguishes good drivers: consideration for others.

Aggressive driving may be safer for only specific categories of drivers, however. The reason: Everybody expects them to drive that way and allows for it.

Two years ago the Safety Project set out to work up a test that could separate the good drivers from the bad. With such a test the worst drivers could be kept off the road—*before* they killed somebody.

But how do you tell a good driver from a bad one? The Project launched a massive mail survey. Thousands of people who in one way or another count as experts (police, judges, teachers of driver education, motor-vehicle administrators) were polled. Each man was asked to send in two "incidents" from his experience: one an example of good driving, one of bad driving.

The Columbia researchers collected more than 4,000 of these incidents. Mining useful information—facts and lessons—from this mountain of crude data was the job of Dr. Malfetti's associate, Jerome L. Fine.

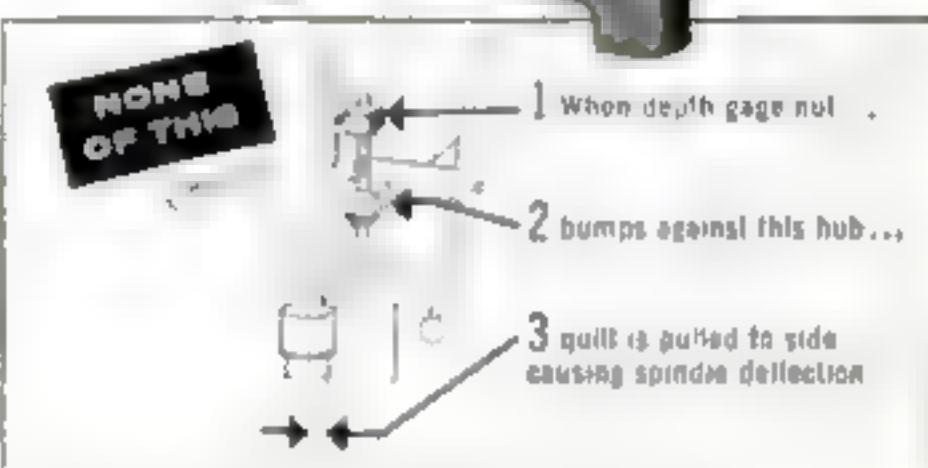
"Good" and "bad." With the information coded into numbers, the sliced-up bits of data were fed to an electronic computer. The computer gave back lists of specific driving actions that had most often been labeled by the experts "good" or "bad."

These lists create pictures of good driving and bad driving. (Slow driving turned out to be the clearest part of the bad-driving image.) They have already been used to design tests to predict drivers' behavior.

Does the system work? Yes, insists Dr. Malfetti. He has tried preliminary tests on several groups of drivers: skillful, safe truckers who piled on hundreds of thousands of accident-free miles, and ticket-collecting types who chalked up so many demerit "points" that state authorities ordered them to attend special retraining classes. The tests checked out, ranking the truckers as the good drivers they were and the persistent violators as the bad drivers they were. ■ ■



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'Keep-'Em-Honest' Car Tests
(Continued from page 72)

tread rubbers have less rolling resistance than do original-equipment tires) and inflated to a maximum of 28 pounds. Wheel bearings are repacked. Engine oil, and transmission and differential lubricant are replaced.

After inspection, all cars were parked in an impound area guarded day and night for the duration of the trials by NASCAR officials. No one was allowed near a car without an inspector present. Cars were taken out when their turn came and returned after making their run.

The economy test run is carefully laid out to give a fair sampling of ordinary, everyday driving. In each 3½-mile lap there's a stretch of winding road with flat hairpin turns, a high-speed strip where the car must do 65 m.p.h., and a full stop. An average of 40 m.p.h. must be maintained for the entire run.

Each car starts out with a precisely measured one gallon of gas in a special tank hung in the right front window and is driven until it runs out of gas. The distance covered is measured to an accuracy of 1/10 of a foot. A NASCAR observer rides in each car, and the only instrument allowed the driver (other than standard equipment) is a stopwatch.

The acceleration test measures the time it takes a car to go from 25 to 70 m.p.h. The timing is completely automatic. On gear-shift models, the driver may not use the clutch before or during acceleration unless he actually shifts. Nor may he ride the brake to help hold constant speed just before the measured acceleration period.

The brake test measures the distance it takes to stop from 60 m.p.h. But there is more to it than just making a single panic stop. Brakes have to make 21 hard stops in rapid succession immediately before the test stop. The drums get hot enough to show the brakes' resistance to fade.

Some of the professional drivers I talked to were not too happy about all this rigmarole. Said one: "They might as well run these cars around the track with robots. If the factory doesn't give you a winning car, you don't have a ghost of a chance of taking home prize money." (Winning drivers got \$500.)

Other drivers took a broader view. Les Viland, an American Motors engineer and one of the top economy drivers in the coun-

'Keep-'Em-Honest' Car Tests

try, told me: "This economy test is tougher than the Mobil Run. You can't make as good a showing here, but everyone is in the same boat, and the results are more realistic."

Viland added to his reputation as an economy driver by going farther in his Rambler American on a gallon of gas than any other car in the trials. He bettered his teammate, also driving an American, by more than five miles. But lest you think there is some magic in his accelerator foot—the other American had overdrive troubles. Because of some malfunction, the overdrive failed to cut in and the entire run was made without benefit of the overdrive gear ratio.

According to Viland, an overdrive will usually account for about four more miles per gallon. The rest of the difference was mainly due to the slightly hotter engine in the other American.

Jockeying for points. With the car makers staking their reputations on the test results, automatic transmissions were not too plentiful. Most elected to use a four-speed box or a three-speed with overdrive. Permitted two entries in each class, manufacturers in some cases set up one entry for economy and the other for performance. Your clue here is rated horsepower. The idea was to garner the maximum total points for the team. In some instances, such as for Chevy in Class III, the plan worked as expected, but not always—the higher-powered Ford in Class I topped its teammate in both economy and acceleration.

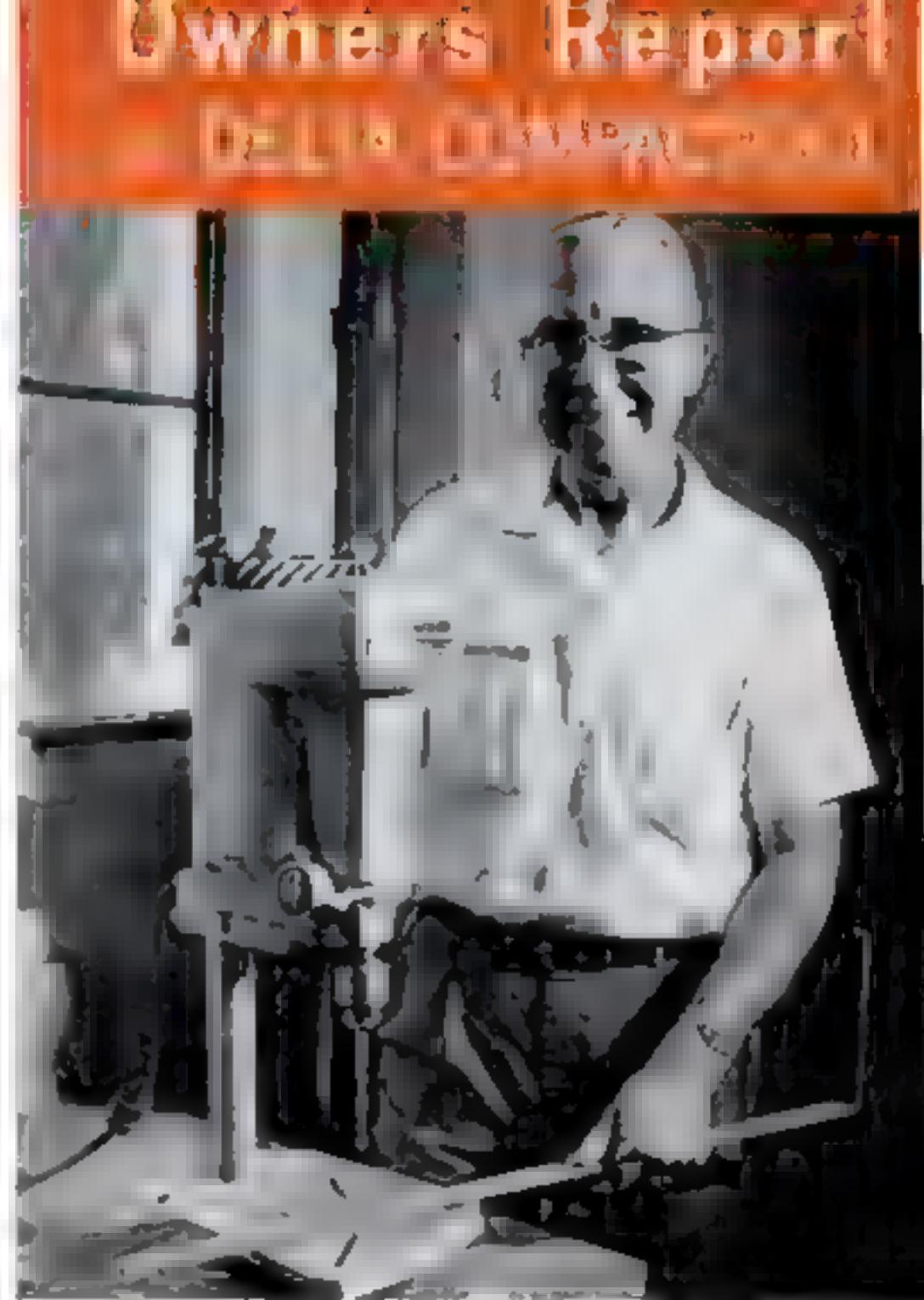
Plymouth made an enviable record for getting both economy and acceleration out of the same engine. In Class IV, one Plymouth copped first place in both tests and its teammate took second in both. In three other classes, they turned in consistently high scores for both tests. At the end of the economy and accelerations tests, Plymouth was ahead in every class in which it had an entry.

At a roundtable discussion with the Chrysler-products team after completion of the first two events—economy and acceleration—I asked what they thought were the most important reasons for their success. They were unanimous in crediting two design factors:

- 1) Less dead weight—their cars are from 200 to 500 pounds lighter than competitors with the same equipment.

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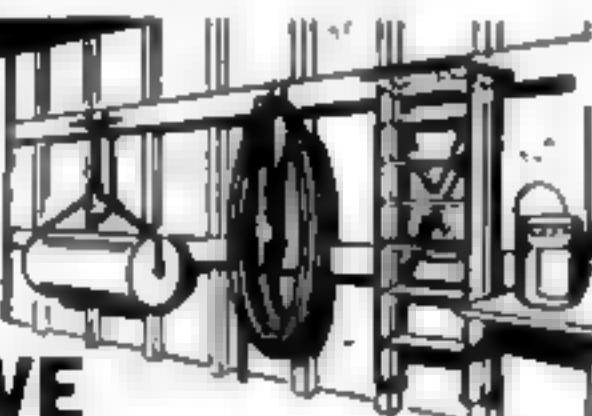
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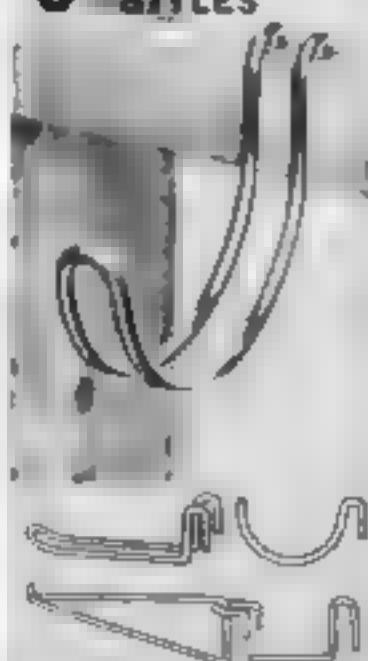
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2) Better handling—Plymouth drivers felt they were getting around the sharp bends in the economy run without losing as much speed as their competitors, and with less energy-wasting swerve and slide.

Doug Patterson, a spokesman for the group, said, "Reducing car weight is the only engineering approach I know of that will improve both economy and acceleration at the same time."

The Chevys in Class III and IV and one Pontiac in Class II also turned in high scores for both economy and acceleration. But most cars performed as you would expect—if they did well on acceleration, they didn't do so well on economy.

What's in it for you? Probably the braking test will have more impact on the design of future cars than any public car trials ever held. To a large degree, the final outcome turned on the scores in this test.

Relatively low braking scores knocked Plymouths out of first place in two of the four classes they had been leading. Their braking scores were low even in the classes they won. Plymouth wasn't alone: 17 out of the 57 models entered took more than 200 feet (some a lot more) to stop from 60 m.p.h. It was proven at the trials that this could be done in 158 feet.

There seems little excuse for such large variations in brake performance. Everyone in Detroit uses the same basic brake mechanism and has access to the same know-how. And, unlike the economy-vs.-acceleration dilemma, there is no engineering reason for compromising on brakes. Nor were better brakes associated with higher price tags. If anything, the reverse was true—some of the poorest results came from the higher-priced models.

The Ford Motor Company chalked up a laudable record on braking with four first places, two seconds, and two thirds. They squeaked into their two overall class victories largely on the strength of the fine braking scores turned in by all four of their cars in Classes I and II.

This annual exposure to public view of comparative brake performance could become the best break yet for car buyers. If the competition for better brakes becomes as fierce as rivalry for acceleration and economy has been, it would be the healthiest influence on Detroit engineering since the threatened mass invasion of the small foreign cars.

Flying the Atlantic Without a Navigator *[Continued from page 88]*

starting point. At that moment he flips the controller's switch to "On," and the "A" side starts registering.

A three-inch dial on his flight-instrument panel, the Doppler indicator, shows ground speed in knots; drift angle, left or right, in degrees; and miles off course. If there's no wind, or a direct head or tail wind, the drift needle reads zero. As the radar beams sense any side winds, the dial shows the drift in degrees—and Horstman changes his compass heading accordingly.

The plane's air speed is a constant 600 knots—but air around us, sweeping forward at 120 knots itself, gives us a ground speed of 720 knots. The Doppler computer, told this by its sensors, continuously figures the distance actually traveled. The miles left to go are clicking off in their window-like your car's mileage meter, running in reverse.

Ten miles before the end of the first leg, a red warning light alerts Horstman to watch the controller closely. When "Miles to Go" reach zero, he switches to the "B" side, for the second leg.

Into the now-inactive "A" side, he dials heading and distance for the third leg. Later, when "A" is working again, he'll put fourth-leg data into "B."

To confirm the readings of Horstman's Doppler, his copilot has a duplicate set. Both sets get a checkup by taking a precision Loran fix before the jet passes beyond range of shore-based Loran stations—and another, as it comes into range of those on the other side.

The innovation has its critics. Understandably not Doppler enthusiasts, the displaced navigators dispute the high TWA-FAA estimate of the system's accuracy. But in its actual use on 2,600-nautical-mile transatlantic flights, reports Chief Pilot Horstman, his Boeing 707s do even better—actually averaging only 2½ miles off course. They clip seven to nine minutes from flight time, save 300 gallons of fuel, by avoiding zigzagging from the shortest route.

Navigating without a navigator looks good to PanAm, too—a different system of its own, using inertial guidance, is on the way. And TWA's Doppler may take over part of the pilot's job as well. Already, in several of TWA's jets, the computer has been linked to an autopilot—which it automatically switches to a new heading at each leg's end.

Clip and save . . . more to come

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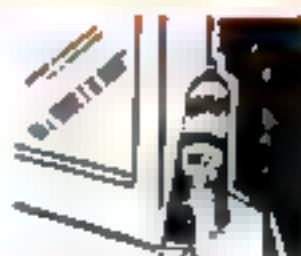
Keeps its neat, attractive satin-white finish to dress-up tile areas in kitchens and bathrooms.



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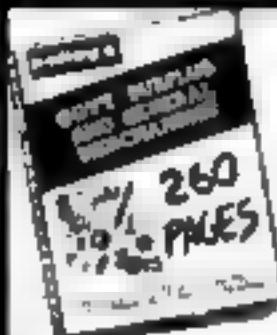
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Time Bombs in the Mississippi

[Continued from page 130]

water, the tank weighed 130 tons. But as it came up, its weight would soar to 350 tons. To this the strongback added its 80 tons. Never before had the hammerheads on the Bolin and the Herman B had to lift 380 tons of death. On the derricks, a half mile of slender cable would be moving on 40 sheaves, and every strand would have to hold.

Joe worried about those tank valves. Pressure in the tank was 85 p.s.i. The valves were set to pop at 160. But suppose they had weakened? What would happen when river pressure, now helping to hold them shut, was taken away?

There was a piece of bad news. On final inspection, a diver reported that the No. 1 tank, again tipping slowly, had raised eight inches off its cradle and had moved dangerously closer to the sharp steel edge. Haste became urgent.

At 2:25, a final briefing was held on the Bolin. It was as solemn as a prayer meeting. Then at 2:30 all hands scrambled, and the Bolin's derrickman, Don Harbolt, climbed to his pulpit.

In his seat at the controls, Harbolt laid his rebreather mouthpiece handy over his shoulder. He looked down over his two great hoisting drums, wound with shiny new steel cable, and glanced across a gap of water toward the other barge, the Herman B. Over there, derrickman K. E. Anderson was climbing to his own cab.

At 2:48, Task Force Chief Boswell on the Bolin radioed Col. Everett, watching from the wheelhouse of the Lipscomb a few yards away: "We are ready to lift, Colonel."

Everett replied quietly: "Proceed, Mr. Boswell."

Simultaneously, a voice said in both Anderson's and Harbolt's earphones: "Lift on both derricks, half speed."

Harbolt flipped two levers, knowing that Anderson, on the other barge, would do the same. There was a rumble. The big drums shifted sideways, to contact the diving disks, and began to turn.

The steam engine on the Bolin is a 50,000-pound-pull, lift-and-draw-works engine, a modern version of an old classic. When Harbolt opened the throttle, steam hissed, a piston slid, and a driving wheel began turning—slowly, then in a fast blur. Harbolt saw his towering derrick shake. The cable,

Time Bombs in the Mississippi
moving in 20 shining strands, drew taut as a violin string. Slowly the drums began to turn.

Then he felt the strain come. Backstays tightened. The steam engine settled down to a brittle puffing, and the whole barge, half as long as a football field, tipped forward slightly under the weight. In its underwater cradle, the tank stirred.

At 2:50 p.m. the Bolin radioed: "The lift has begun." The word flashed to Natchez, Washington, New Orleans. It was heard in homes, stores, cars, by 70,000 anxious people. Miles away, ships heard and stopped. In his wheelhouse, Col. Everett spoke quietly into his microphone: "All communication channels please stay clear for emergency."

Far down in the wreck, the tank settled slightly and a quiver ran up the cables—a kind of nervous burp. Then Harbolt fed more steam. At three p.m. the tank was coming up 18 inches a minute.

Joe Carroll, ready to dive if needed, was worried. He knew that a major adjustment was now at hand.

Then Harbolt got a signal to stop while the Herman B brought up its end to put the tank on an even keel. Still 15 feet under water, the tipsy tank began to level off. Harbolt fed steam again and the derricks on the two barges once more lifted together.

At 3:17 someone standing near Carroll whispered, "Great God!" A clammy white shadow grew in the water, just under the surface, growing imperceptibly brighter and flickering with ripples. At 3:19, the No. 1 tank shouldered its way out of the river, slow as a rising moon.

All hands had known it would be big, but none expected anything like this. The clammy thing kept growing, a monster coated with slime, sand, and dirty water. Gas-suited chemists waited like Lilliputians to board it and plug any leaks. Men with detectors were everywhere, spraying the air.

The daring little motorboat Corky now shot out and sprayed the rising valve-dome. But there was no sign of gas: The tank still was holding.

The major adjustment came moments later. With no warning, one sling cable lost its grip and slipped.

It happened in a wink. A new ripple raced up the hoist cables. Harbolt felt it



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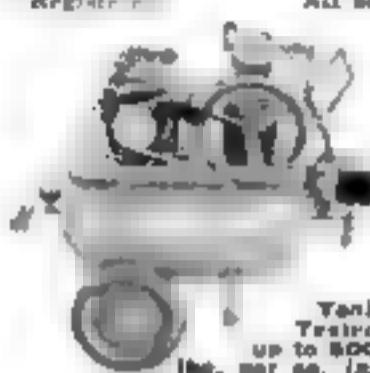


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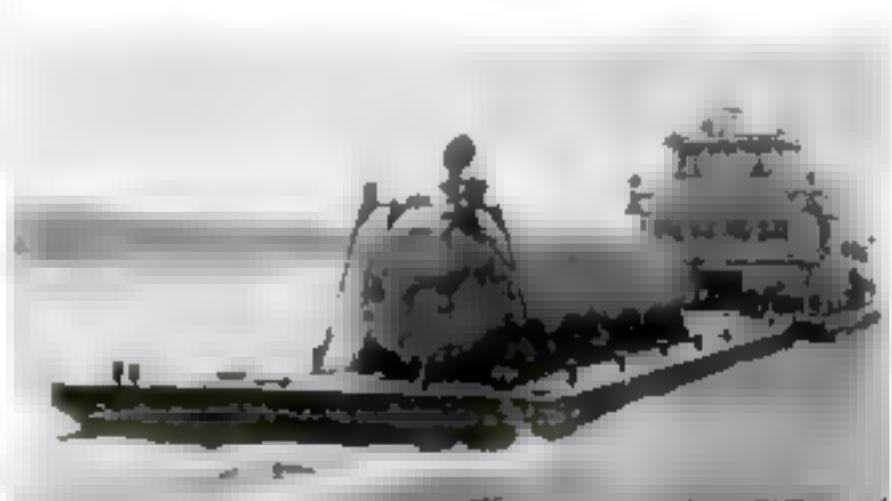
in his derrick. Then, all together, the sling cables slipped.

An ugly clang sounded from the tank. The 30-ton strongback lost its grip and began to slide. Then—with an enormous shock—it caught a new grip. The shift was over almost before it began. The steam engines kept their steady, silky pull as if nothing had happened.

By 3:21, the No. 1 tank was up. Water jets were turned on the slimy metal so men could go aboard, without slipping, to ram caps over the valve. A barge took the horrible thing away. As the tank sailed down the river, its tough white paint glistened.

"That," said a watching diver, "is what held the whole damned thing together." The epoxy resin that had so brutally fought the torches had with equal stubbornness fought off the rust that could have brought disaster.

It had been an incredible 10 days of frightening work, without pause day or night. And there was more to come. But by November 5, the other tanks were recovered and eight tired divers threw their badly battered helmets into trucks and headed back to Texas.



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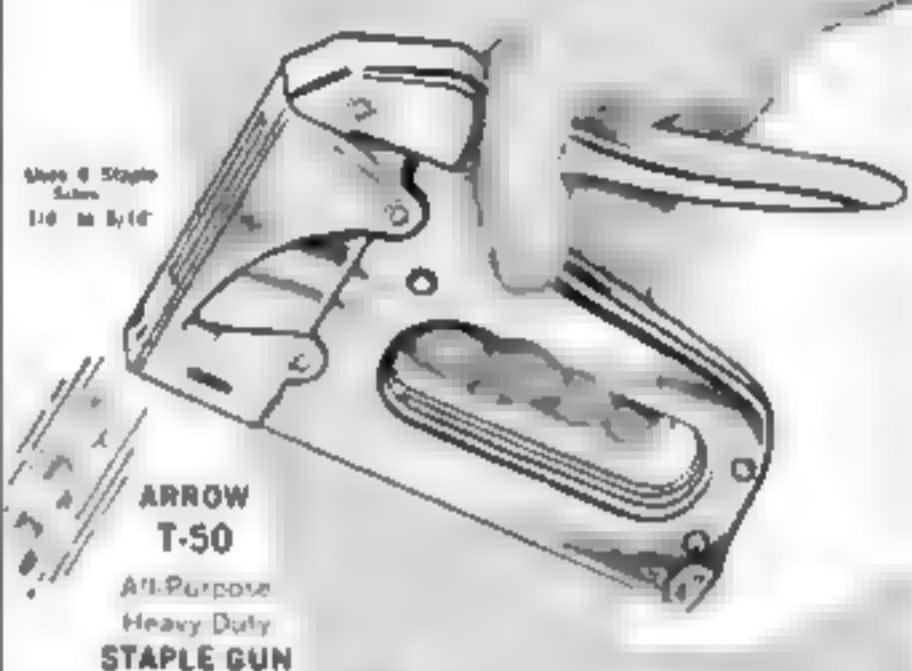
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Weightless Workshop

[Continued from page 112]

and plant visitors stared. (The first astronaut with glasses.) Cording and several coworkers marched me to the machine and strapped me on. I started sweating.

"Ready?" I wasn't, but I nodded. Cording plugged in the air hose, and I felt the machine rise slightly and start to slither around the floor. Then he pulled loose the bar that held me upright.

The room whirled—and there I was, standing on my head. A couple of technicians hopped over and pulled me upright again. "Sorry," one of them said, "You're top-heavy." More adjustments.

The bar was pulled loose again, and I floated in space. All my fear vanished. The sensation was fascinating: A little jerk of the head and I spun around. A snap of the arm and I stopped. I blew sharply, and in slow motion did a flip on my axis.

"Now let's see you do some work," said Cording. He shoved the machine to where he had set up a repair problem.

Working Phillips-head screws was easy. Though steady pressure can't be used, screws can easily be cracked loose or tightened with a jerk of the arm and hand. The wrench was a little tougher to work. The nuts were on tight, and I had to use body mass as leverage. When I mistimed the yank, the nut wouldn't turn; I would.

By then perspiration was running into my eyes. The crew unstrapped me. My knees were wobbly. I was bone-weary.

Later, I asked Cording why. "You worked harder than if you were on the ground," he explained. "A man under zero-G conditions may use 30 to 40 percent more oxygen than he would doing the same work on earth."

Other things Spaceworker has shown:

- Man can adapt to weightless conditions more easily than had been supposed.

- Special tools—reactionless wrenches, for example—will be needed only for odd jobs, where extra leverage is required, or in hard-to-get-at spots.

- A supporting belt will be necessary—perhaps like a window washer's harness—attached to the spaceship's hull.

The next GE research step will be to balance the work panel so it "floats" up and down—the only plane in which Spaceworker can't move. And early this summer, Cording expects to develop a propulsion system—a back pack or gas belt. ■ ■

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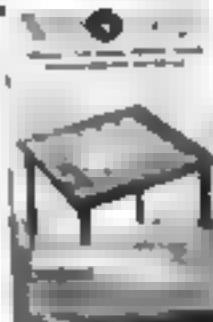
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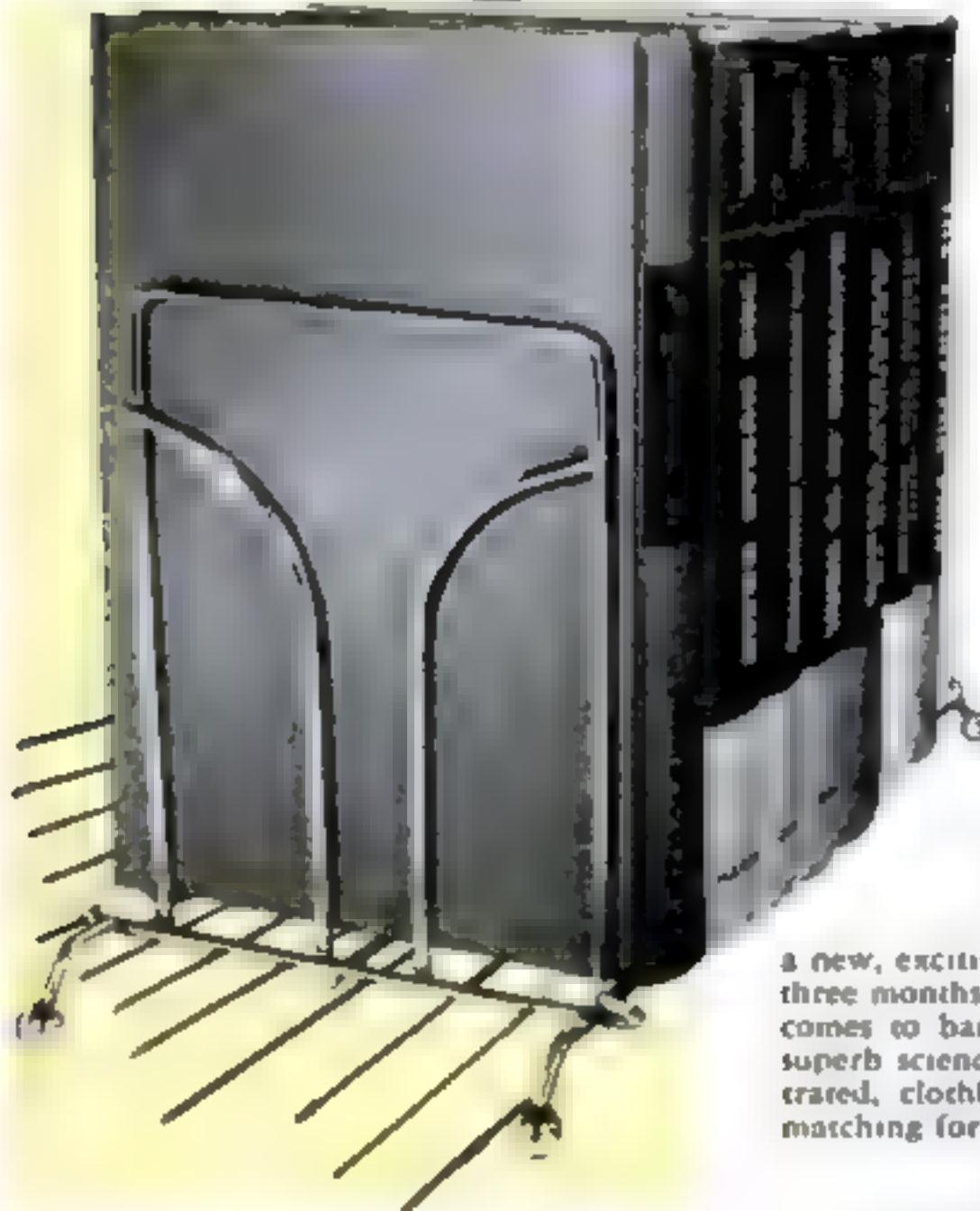
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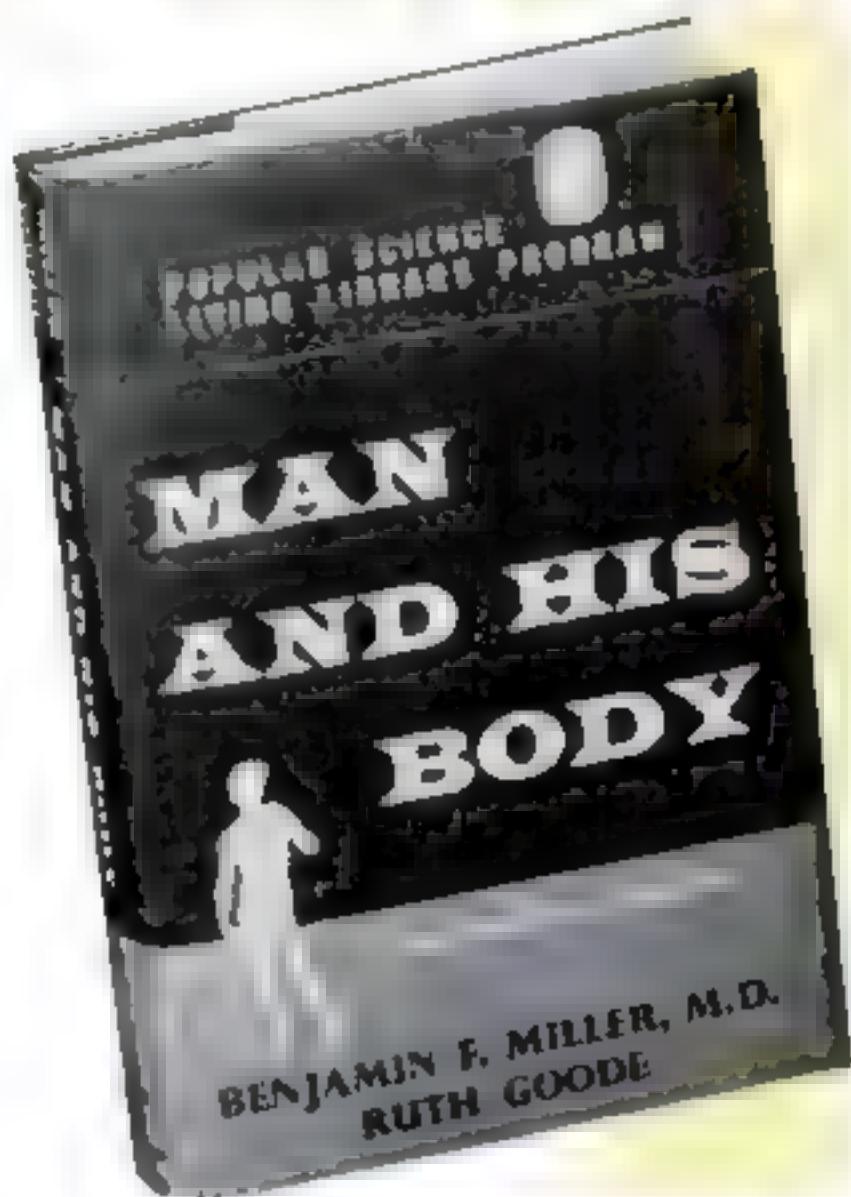
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Move In Close
[Continued from page 150]

they require no exposure increase. The distance between lens and film does not increase, so the same amount of light reaches the film. Supplementary lenses, generally, are used only on cameras lacking removable lenses.

Bellows and tubes. Physically moving a lens away from the camera is the simplest way to record a large image on film. But only the more expensive cameras, using interchangeable lenses, accept the focusing devices that do this.

Two types, generally, are available: fixed extension tubes and the more versatile bellows units. Extension tubes of various lengths are marketed by a number of manufacturers, usually for their own cameras. One end of a tube fits the lens mount, the other fits the lens. The fixed length of a tube limits its use somewhat. But in combinations, they provide several reproduction ratios.

Because it provides continuous adjustable focus, an extension bellows is the most versatile. Practically all cut-film cameras have their own bellows, but most 35mm and 120 roll-film cameras require auxiliary bellows attachments to adapt them to this work. While a bellows unit costs considerably more than extension tubes, it is well worth the price.

Focal frames come in handy when you add a supplementary lens or an extension tube to a camera that has neither ground-glass focusing nor an auxiliary range- and view-finder. Not only do they measure off the correct lens-to-subject distance, but they show exactly the area included.

Exposure. With detail so important in close-ups, it's best to use the minimum exposure required to record the needed tonal details. Overexposure increases graininess, reduces sharpness and tonal separation. It produces negatives difficult to print.

As you rack out the camera bellows or add extension tubes to increase the lens-to-film distance, you must increase the exposure. Focusing at normal distances, exposures are unchanged. But as the lens is moved close, the indicated f-number (stop) is no longer effective. One easy way (without formulas) to figure the new f-number: Measure the lens-to-film distance and use the effective-aperture computer in the Kodak Master Photoguide to read off the modified exposure.

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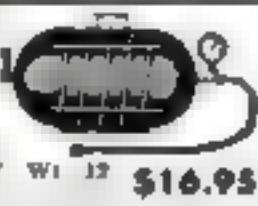
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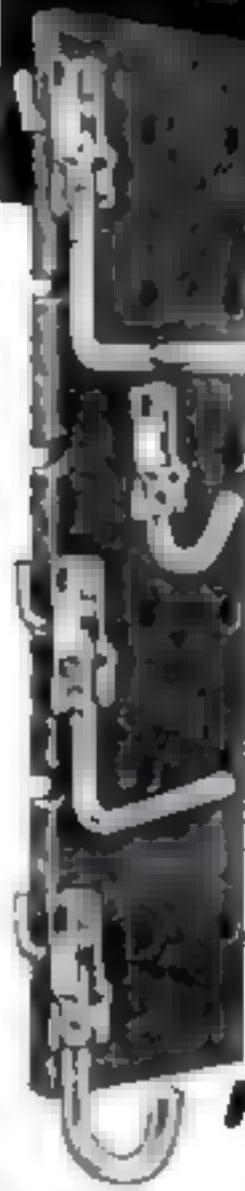
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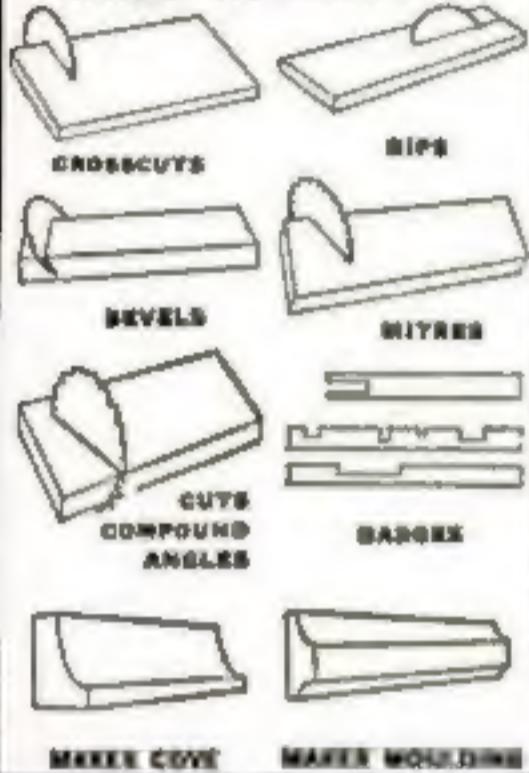
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American Machine & Tool Co., Dept. PS-43B, Royersford, Pa.

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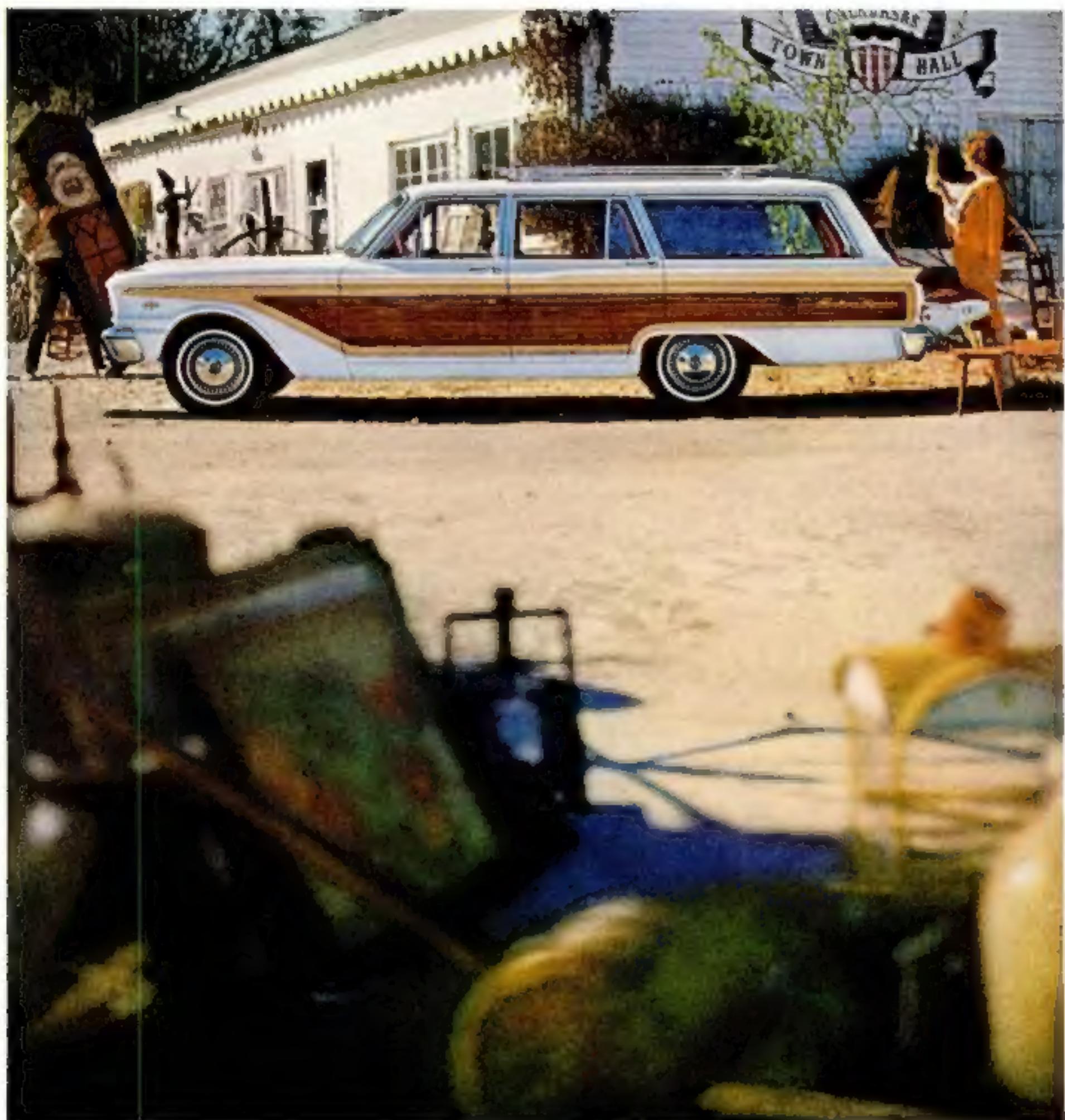
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